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EUGENICS

Edgar Schuster

EUGENICS

by

EDGAR SCHUSTER

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PREFACE

In this volume I have attempted to give an account of the meanings of the word Eugenics, the aims of those who advocate a eugenic policy, and the more important of the problems which confront them. I have kept distinct the descriptions of certain researches directed towards the elucidation of these problems, in order to show as clearly as possible in what manner the work is being done; but I have endeavoured at the same time to indicate the bearing of each research on the subject as a whole.

It is now my pleasant duty to thank those who have helped me, particularly Mrs A. C. Gotto and Mr A. F. Schuster. They both read the manuscript most carefully and most kindly criticised it, thereby enabling me to eliminate much that was obscure or illogical, ungainly or ungrammatical. To the former I am also indebted for a good deal of the information contained in Chapter III., and for many of the ideas expressed in Chapter XI., and to the latter for finding me the relevant passages in

Plato's *Republic*. To Dr F. C. S. Schiller my thanks are due for what has been taken from Plato's *Laws*, and to Mr A. S. L. Farquharson for such knowledge as is displayed of the writings of Theognis and Aristotle, and also for reading and criticising the whole of Chapter II. For help on other points I would express my gratitude to Mr G. W. Smith and Mr R. R. Marrett.

It is difficult to estimate exactly what one owes to published sources. Those from which special information is taken can be and are mentioned in the text or in footnotes; but there are some works whose influence on one is more general, and these it is impossible to deal with in this way. Though doubtful of the propriety of naming particular authors among the many whose works might be included in this class, I would be ungrateful not to acknowledge a certain debt to Mr and Mrs Whetham and Mr Havelock Ellis.

EDGAR SCHUSTER.

OXFORD, *Dec.*, 1912.

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CHAPTER I

INTRODUCTION

THOSE who seek to introduce a fresh policy into the regulation of human affairs must have clearly before them what end they desire to attain by so doing; and if they wish to commend their policy to the majority, they should be prepared to demonstrate that the end itself is desirable, and that by the means proposed there is some hope of moving towards it. There are some who would claim that the ultimate goal of Eugenics is a patriotic one—namely, to increase the commercial and fighting efficiency of the nation. We do not, however, intend to advocate it on these grounds, but would rather recommend it as a road to increased happiness for the human race; or, at any rate, as a means of preventing much unnecessary misery.

Sanitation, education, and the arts of medicine and surgery, to name some of the lines of progress along which mankind has moved during the last century, have

essentially the same end. They endeavour to accomplish it by enabling each individual born into the world to develop the best that is in his nature, both of the body and of the mind, so that his life may be lived with satisfaction to himself and profit to the community, and that it may be unspoilt by accident or disease and unhampered by ignorance or vice.

At present, 'the best that is in his nature' is often a poor thing. Eugenics aims at making it a little better by whatever means may prove practicable. In this it differs from, and goes farther than, the agencies enumerated, whose efforts it seeks to supplement, but not to supersede. Eugenists form no homogeneous sect or party, recognise no common leader, are confined to no country, and differ widely in their methods and beliefs; but they appear to the present writer to subscribe implicitly, if not explicitly, to a common creed, which may be outlined as follows:—Each individual, as he passes through life to its end in death, derives his active qualities at each moment, of whatever nature they may be, from the interaction of two separate, yet not wholly independent, causes. The one may be called his inborn potentiality or capacity for development; the other the environment, or the mental, moral, and physical surroundings in which his life is spent.

The inborn potentiality may have a material basis in the chemical or mechanical constitution of the body, or some part or parts of it, or may depend on some mysterious property of living matter, unknown entirely to physical science. We need form no opinion of its ultimate nature, yet may agree that it is largely derived from a similar capacity inherent in the parents or ancestry. This is the true meaning of heredity. We have no direct means of judging what potentialities are present in any individual case, but can only observe what active qualities of body or mind present themselves, and accordingly the outward manifestation of heredity is the similarity shown between parents and children, ancestors and descendants, with regard to these. The inborn potentiality has been called 'nature,' while the term 'nurture' has been used to denote the environment which works on it as it unfolds into recognisable qualities. Both these terms lack something in precision, and have degenerated into catch-words; yet, as there is nothing better to substitute for them, they will be used in the senses just defined.

Eugenists differ from others who may equally have the good of mankind at heart, in that they assign a greater relative weight to nature; they believe that the greatest good of the greatest number may be achieved

by selecting as far as possible the best that is provided by nature, although they may also strive to effect improvements in nurture. They believe that if among men and women those who are by nature better in mind and body leave more progeny behind them than those who are worse, mankind will enter into a continuous advance towards increased happiness. The enormous and indisputable changes produced by artificial selection in domestic animals, as well as the incomparably greater changes in wild animals, attributed by the Darwinian theory to natural selection, are evidence of a weapon ready to the hand of him who can wield it. The Eugenist does not wish to follow blindly the methods employed either in the one case or the other, but rather to devise some course of action which is suited to human conditions as we know them; not to ride rough-shod over the spiritual feelings and aspirations of mankind, but to take all into account and to seek a use for all.

The foregoing remarks may be taken as roughly indicating what Eugenics is in so far as the word is used to denote a belief, or rather an ideal. As a belief it is somewhat vague, and one which needs to be made much more definite before it can be translated into a practical policy. It is here that the science of Eugenics must be called to our aid: a science defined by Sir Francis

Galton as 'the study of those agencies under social control, which may improve or impair the racial qualities of future generations, either physically or mentally.' The words 'social control' should be taken to indicate that the practical bearing of the study must not be lost sight of. It has for its aim the discovery of means by which social control may be applied for the improvement of the race. If we were to limit ourselves too rigidly by the definition, and in practice only to study agencies which we know to be under social control, little progress would be made, for we cannot tell until after the study has been completed what natural laws or social reactions can be consciously controlled by the individual or collective wills of any human group.

The endeavour must be made to understand as completely as possible all those forces, whether they be customs, economic relations, habits of life, or bearers of death, which may affect the nature of these thousands who are daily born, either by altering for good or evil the qualities of individuals, or by increasing or diminishing the proportion of the better to the worse.

We are told by some that there is no science of Eugenics, but those who say so either define the term in some special way or have not followed the work which has been done in the subject in recent years. A common

dictionary definition of a science is that it is a 'department of knowledge reduced to system'; but this definition neglects the idea of growth and change which are essential features of a living science. The knowledge must be systematised in such a way as to show where fresh material is needed and to facilitate its acquisition. That there is a science of Eugenics in this sense can fairly be claimed, although it is merely a foundation built with borrowed capital; but there is no mortgage on the building, no interest to pay, and no principal to refund, for wealth of this kind may be borrowed freely as often as it is wanted.

Already many facts, inferences, and hypotheses have been placed in orderly array, and many problems have been defined which, like the architect's plans, should guide the further labour of the builders. It is the principal purpose of this volume to describe the former and define the latter in so far as it may be possible within the necessary limits. At the outset it may be as well to pass in brief review the problems with which we have to deal.

First among these comes heredity. The dictionary tells us that this is 'the transmission of characters or qualities of parents to their offspring.' We will not for the moment quarrel with this definition; although it is not in accordance with modern scientific

views, it expresses roughly the older ideas on the subject and the popular opinion of the present day. Undoubtedly heredity manifests itself in the apparent transmission of characters or qualities of parents to their children, and, in consequence, two questions or groups of questions are raised. In the first place, to what extent and in what manner does this transmission occur, and what kind of characters or qualities are transmitted; secondly, by what mechanism is the transmission brought about.

Heredity is placed first among the constituent parts of the science of Eugenics because, more than any other agency, it moulds the racial characters of future generations. About this there can be no dispute. Without heredity, reproduction would be inconceivable, since the very term reproduction implies that like produces like; and without reproduction there would not be any future generations of mankind. This may appear to be a fallacy, but it is not in reality. The appearance is due to the fact that the word heredity has been used in a different and truer sense to that with which we are most familiar. The qualities which strike our attention as being inherited are those which are not common attributes of the race, species, or variety, but are peculiarities shown both by the apparent transmitter and the inheritor. Thus, when one

talks of heredity, one usually means the transmission of some peculiarity or special feature; but the common characters of the species or larger groups are as truly and more surely inherited, and if this were not so one could not talk of reproduction at all; there would, in fact, be no reproduction, though fresh living things might be produced.

Heredity may be looked on as the agency principally concerned in determining 'nature' or the inborn potentiality. The next main question concerns nurture. Stated in a very simple way, it runs thus: 'How far can differences of nurture acting on natures of an exactly similar kind produce realised differences of quality?' Or in a more concrete form one might ask to what extent are the great differences which we observe in the appearance, intellect, health, habits, and morals of human beings due to differences in their bringing up and in all the outside influences working on them, and to what extent are they due to their diverse inborn potentialities? Such questions are among the hardest problems to be faced; but in order to establish a case for Eugenics it is not necessary to find a complete solution. It must, however, be shown that a considerable part of the differences referred to are due to 'nature.'

We can pass on from these to another group of problems centred round the question:

Will the outside environment acting on the parents affect them in such a way that the nature of the children will be altered? As a particular example, we may take the inquiry into the influence of parental alcoholism in the offspring, about which so much controversy has raged during the last two years.

The next division of the subject concerns neither nature nor nurture, but selection. Classify the human race how one may, if each class reproduces itself at exactly the same rate heredity would have no action on future generations, whether for good or evil. But directly any sort of selection of particular classes occurs, of such a kind that they multiply at it may be only a slightly higher rate than the rest, then heredity becomes a potent force in altering the destiny of mankind. In the first case it ensures constancy, and the second change. Thus, in addition to heredity, the selective agencies call for the earnest attention of Eugenists. These may be defined as the forces, tendencies, or events, whatever they may be, whether social customs, or economic pressure, or accidents of various kinds, affecting mankind in such a way that certain classes or groups of individuals reproduce themselves at a higher or a lower rate than the rest. We probably recognise only a few of the selective agencies, but we are beginning to find out

something about some of them, and of these the differential birth-rate may be ranked as the most important.

The difference between the birth-rate and the death-rate of any group would give its rate of increase if it were isolated, that is to say if it could not increase its numbers by immigration or reduce them by emigration of one kind or another. Thus the importance of the birth-rate will easily be understood. The birth-rate itself depends on things, such as the proportion of people who marry, the average number of children per marriage, and the duration of time between successive generations. Its differentiating action can be of many different kinds. It may cause one nation to increase at a higher rate than others. It might, and is indeed supposed to, affect the relative increase of different social classes, and of different religious or racial groups within the limits of a single nation; and, finally, within each of these classes or groups, individuals with particular characteristics might through this agency tend either to multiply or to die out.

After classifying mankind in any or every way, Eugenics should therefore concern itself to discover which classes a high birth-rate is assisting to multiply more rapidly than others. It can then set about a problem of a different type, and obtain information without which the question of the relative increase of different

classes would be of very slight interest. The problem can be stated more easily by giving concrete examples. It is said that the higher social classes reproduce themselves at a lower rate than the rest, and thus that society is always recruiting itself from below. Let us grant that we know this for certain, yet in order to determine whether it is a fact of Eugenic value as tending to improve mentally and physically the racial qualities of future generations, or dysgenic in its action as tending to impair them, it is necessary to determine whether or no the higher classes have a heritable superiority in body or mind. Similarly, when we are told that Roman Catholics have larger families than Protestants, we want to know whether their religious beliefs are merely accidental or whether they spring in part from some inborn intellectual or emotional peculiarity. If the latter is the case, we must further ascertain whether such characteristics are likely by their perpetuation and multiplication to benefit mankind or not.

In the study of these questions Eugenics must borrow from physical anthropology and the modern psychology, which proceeds by observation and experiment; and, above all things, it must endeavour to determine the relative parts played by 'nature' and 'nurture.' We thus get back again to a branch of the subject that has already been

referred to and for the time dismissed, and this shows how closely bound together the whole subject is, and how impossible it is to subdivide it in a really logical manner.

A consideration of differences in birth-rate leads on to the discussion of their causes. How far are they due to differences in natural fertility? How far to other factors?

No less effectively than the birth-rate the death-rate may be selective on its action. For instance, it is urged by some that the mortality which is always heavy among infants may actually tend to improve the physique of the race by removing those who are on the whole weaker than the survivors. If this is the case, it is an instance of a selective death-rate acting on the whole in a Eugenic manner. Other authorities point out that as the components of an army at the time of a great war are on the whole superior in physique to those who follow occupations at home, the death-rate of a large proportion of them, taken more or less at random, on the battle-field or in the camp, will have selective action of an exactly opposite kind, in that the better will be taken and the worse be left. The death-rate from particular diseases may be selective primarily in its tendency to remove those persons most liable to it, but secondarily if any special mental or physical quality is associated with the tendency.

Any practice which encourages or discourages marriage among certain classes may be selective in its action if the classes affected differ in some respect from the average. A modern example of this may be found in aviation. The army regulations discourage marriage among the military aeroplanists; thus a small body of men highly endowed with many noble qualities are prevented from reproducing their kind. This is not brought forward in any way as a criticism of the regulation referred to, which is no doubt perfectly wise, but merely as an example of marriage selection. Its dysgenic consequences fade into insignificance before those of the appalling death-rate among aviators. Among the older instances of marriage selection possibly dysgenic in effect was that set up by the regulations, now largely relaxed, which confined the holding of fellowships at Oxford or Cambridge Colleges to bachelors; while the celibacy of the priests in the Roman Catholic Church may also have had a tendency to weed certain qualities out.

A historian wishing to advance the study of Eugenics could perform no more useful task than to trace the effect of any of such selective agencies as have here been referred to on the rise or fall of some race or nationality.

Let us take as the next branch of the subject the causation of some special qualities

which seriously influence the welfare of the race. Idiocy, Insanity, Tuberculosis, on the one hand, and general or special ability on the other, may all be reckoned as belonging to this class. The same questions recur concerning them: How much are they due to nature, how much to nurture? If among the forces that produce them some are inborn, to what extent are these transmitted by inheritance, and in what manner?

As a preface to the practical application of anything that Eugenics may teach, it is necessary to consider it in yet another way. Hitherto many questions have been outlined, and as it will be seen later to only a few can answers be given; but one problem, and that one of the most vital, has not been touched on. How can any of the agencies under consideration be consciously and deliberately controlled? To what extent and in what direction are laws effective? What social customs or economic conditions make for racial improvement, and how can they be extended? It is necessary to investigate existing conditions and to analyse their tendencies to see how they may have acted in the past, and with what results. Marriage laws and customs should receive the particular attention of Eugenists, though many other social phenomena may have almost as direct and as far-reaching an influence.

But besides describing what is or has

been, it may be needful to discuss suggestions for future action. In this connection it is necessary to state emphatically that legislation for Eugenic purposes is advocated by very few Eugenists. The majority would view the introduction of laws of this kind with profound distrust. When legislation of any particular kind for Eugenic purposes is being discussed, it is assumed by their critics that Eugenists necessarily advocate it. As it is often both futile and antagonistic to some principle of tried and recognised value, the spread of Eugenic ideals may be seriously impeded by such an assumption. So it is necessary to insist that the acceptance of these ideals does not imply adherence to any public policy of any kind whatsoever or approval of any special propaganda.

SUMMARY OF CHAPTER

Eugenics has for its ultimate object, no less than other means by which civilisation advances, the betterment in body and mind of the human breed. The methods on which Eugenists rely aim at influencing the inborn nature of men rather than improving the external conditions. They are not to be regarded as antagonistic to, but rather as supplementing, such agencies as sanitation, education, and the varied arts of medicine. For the effective realisation of the Eugenic

ideal a science of Eugenics is necessary, and of this science the foundations have already been laid. The questions which it is expected to answer are reviewed under six headings, but it is not claimed that they have been logically or exhaustively classified. They are briefly recapitulated below:—

(I.) Heredity. To what extent and in what manner does the hereditary transmission of characters occur, and by what mechanism is it effected?

(II.) In the development of individuals, what share is taken by 'nature' and what by 'nurture'?

(III.) In what manner and to what extent does the parental environment directly act on the 'nature' of the children?

(IV.) What influences can be detected which tend to increase or decrease the rate of multiplication of particular classes or races or groups of men having any differentiating characters in common? (This question raises a large number of subsidiary ones.)

(V.) What causes bring about the advance or decline in the prevalence of special characters which we know or believe to be good or bad?

(VI.) How can social control be applied to 'improve the racial qualities of future generations, either physically or mentally'?

CHAPTER II

EUGENICS IN ANCIENT TIMES

EUGENICS is no new idea. It is suggested in the following passage taken from the works of the Greek poet Theognis of Megara, who wrote in the first half of the sixth century B.C. Addressing his friend Cyrnus (*Elegies* 1183–192), he sings: 'We look for rams and asses and stallions of good stock,[1] and one believes that good will come from good; yet a good man minds not to wed an evil daughter of an evil sire, if he but give her much wealth. . . . Wealth confounds our stock. Marvel not that the stock of our folk is tarnished, for good is mingling with the base.' About a century later Eugenics was discussed in some detail by Plato in the *Republic* and the *Laws*. In the former of these works Socrates is represented as laying down conditions for an ideal republic—the first Utopia. The scheme is developed in a series of conversations with friends of diverse character, who from time to time raise objections which Socrates meets with much cleverness and

[1] It is interesting that the word εὐγενέας is here used. The translation is by Mr A. S. L. Farquharson of University College, Oxford, who kindly called my attention to the passage.

humour. The passage in which the idea of selective Eugenics on stock-raising lines is stated with the greatest clearness is a dialogue between Socrates and Glaucon. Glaucon is a young man of quick penetration, of distinction as a soldier, and experience as a lover; fond of art and music, and, what is of most importance in this connection, a practical and successful breeder of dogs and birds.

Socrates says to him :—[1]

'And how can marriages be made most beneficial?—that is a question which I put to you, because I see in your house dogs for hunting, and of the nobler sort of birds not a few. Now, I beseech you, do tell me, have you ever attended to their pairing and breeding?'

Glaucon.—In what particulars?

S.—Why, in the first place, although they are all of a good sort, are not some better than others?

G.—True.

S.—And do you breed from them all indifferently, or do you take care to breed from the best only?

G.—From the best.

S.—And do you take the oldest or youngest, or only those of ripe age?

G.—I choose only those of ripe age.

S.—And if care was not taken in the

[1] Jowett, *The Dialogues of Plato.* Vols. III. and V. (Edition 3.)

breeding, your dogs and birds would greatly deteriorate?

G.—Certainly.

S.—And the same of horses and animals in general?

G.—Undoubtedly.

After some further conversation Socrates arrives at the conclusion that the rulers of his ideal republic would have to manipulate the unions of the citizens in such a way that the best of them should have the best mates, and the worst should intermarry among themselves. To avoid all the unpleasantness which he foresaw might arise from too much interference of the rulers in such a delicate matter, it would be absolutely necessary that the citizens should know nothing whatever about it. So it is suggested that persons of marriageable age should be brought together at semi-religious festivals, where, to the accompaniment of suitable hymeneal songs, they would draw lots for their mates. But Socrates goes on to say: 'We shall have to invent some ingenious kind of lots which the less worthy may draw on each occasion of our bringing them together, and then they will accuse their own ill-luck and not the rulers.'

The less worthy, after being cheated into putting up with marriages against their inclinations, were not prevented from reproduction, but good care was taken that their

infants should not grow up in the republic. As for other reasons it was thought most desirable that all children should be brought up together in public crèches, and that no parents should know which children were theirs, this little matter could be easily attended to, for Socrates suggests 'The proper officers will take the offspring of the good parents to the pen or fold, and there they will deposit them with certain nurses who dwell in a separate quarter; but the offspring of the inferior, or of the better when they chance to be deformed, will be put away in some mysterious unknown places, as they should be.'

The children were to be suckled by the mothers, but care was to be taken that no mother recognised her own child. 'Care will also be taken that the process of suckling is not continued too long, and the mothers will have no getting up at night or other trouble, but will hand over all this sort of thing to the nurses and attendants.' In order to prevent immature or senile parents[1] from having children, only women between twenty and forty years of age, and men between twenty-five and fifty-five, were to be allowed to attend the hymeneal festivals, and the total number of marriages was to be regulated

[1] The importance of marrying in one's prime had no doubt been recognised much earlier by the Gnomic Poets of Greece (see Hesiod, *Works and Days*, line 695 and following).

in such a way as to keep the numbers of the population at the most suitable level.

In time of war, those who distinguished themselves in battle were to be rewarded by State aid in their love affairs. 'The brave man is to have more wives than others;' 'he is to have first choice in such matters more than others, in order that he may have as many children as possible.' Thus we see that Plato suggests both the abolition of the household and polygamy for Eugenic purposes.

The relation between medicine and Eugenics is often discussed at the present day, and some people maintain that in so far as medical aid allows the weak and sickly to survive and propagate their kind, it may in benefiting the individual do harm to the race. This was the view expressed very clearly by Plato; in a half-humorous passage he compares the older system of medicine with that practised in his own day, much to the advantage of the former. The following extracts of the remarks which he puts into the mouth of Socrates give the gist of his meaning:—

'If Asclepius (by whom he typifies the older school) did not instruct his descendants in valetudinarian arts, the omission arose, not from ignorance or inexperience of such a branch of medicine, but because he knew that in all well-ordered States every individual

has an occupation to which he must attend, and has, therefore, no leisure to spend in continually being ill.' . . . 'And therefore our politic Asclepius may be supposed to have exhibited the power of his art only to persons who, being generally of healthy constitution and habits of life, had a definite ailment; such as these he cured by purges and operations, and bade them live as usual, herein consulting the interests of the State; but bodies which disease had penetrated through and through he would not have attempted to cure by gradual processes of evacuation and infusion: he did not want to lengthen out good-for-nothing lives, or to have weak fathers begetting weaker sons.'

Selective Eugenics was to be assisted by Lamarckian Eugenics. 'For good nurture and education implant good constitutions, and these good constitutions taking root in a good education improve more and more, and this improvement affects the breed in man as in other animals.'

The idea of Eugenics is further developed in the *Laws*, in which work also an ideal scheme of government is suggested. This differs from that proposed in the *Republic*, in that the monogamous household is retained in a shadowy form. It will be seen that on many points modern ideas are foreshadowed with curious exactness. The taxation of bachelors, for example, has many serious

advocates at the present day, whose ideas could hardly be expressed more clearly than in the following passage: 'He . . . who does not marry when he has arrived at the age of thirty-five, shall pay a yearly fine of a certain amount, in order that his celibacy may not be a source of ease and profit to him.' The object of this suggested regulation was not to maintain the birth-rate at a satisfactory level, but rather to check the 'impiety' of refusing so good a gift as a wife and children.

Plato's treatment of 'Alcohol and Eugenics' should also warmly commend itself to many modern exponents of the dangers of alcoholism. 'Drunkenness is always improper, except at the festivals of the God who gave wine; and peculiarly dangerous when a man is engaged in the business of marriage, for at such a crisis in their lives a bride and bridegroom ought to have all their wits about them, and they ought to take care that their offspring may be born of reasonable beings; and who can tell on what day or night Heaven will give them increase? Moreover, they ought not to be begetting children when their bodies are dissipated by intoxication, but their offspring should be compact and solid, quiet, and compounded properly; whereas the drunkard is all abroad in all his actions, and is beside himself both in body and soul. Wherefore, also, the drunken man

is bad and unsteady in sowing the seed of increase, and is likely to beget offspring who will be unstable and untrustworthy, and cannot be expected to walk straight either in body or mind.'

It is not altogether clear whether Plato means that the general effect of parental alcoholism in the offspring is deleterious, or that the danger principally lies in the procreation of children during moments of intoxication; or again, whether he fears that the moral effects of habitual drunkenness on the drunkard are likely to be inherited.

Temperance reformers at the present day are alive to the possibility of the second of these three alternatives; but the view that habitual alcoholism on the part of the parents has the effect of poisoning the germplasm[1] out of which their children are formed, and thus causing defects, is held more widely.

With regard to the choice of mates, Plato gives in the *Laws* the following advice, which has a definitely Eugenic purpose;—'People must be acquainted with those into whose families they marry, and to whom they are given in marriage; in such matters as far as possible to avoid mistakes is all-important, and with this serious purpose let games be instituted in which youths and maidens shall dance together, seeing and being seen naked, at a proper age and on

[1] *Vide* Chapter IV. for definition of germplasm.

a suitable occasion, not transgressing the rules of modesty.'

He further goes on to say that for the benefit of the State one should avoid the natural inclination to marry one who is similarly situated to oneself, both with regard to personal characteristics and to pecuniary circumstances. A rich man should marry into a poor family, and a dull man into a quick-witted family. An equable population without too much diversity in mind, body, or estate among its members would thus result. After marriage 'the bride and bridegroom should consider that they are to produce for the State the best and fairest specimens of children which they can.'

The *Laws* was written some time after the *Republic,* when the author was at least seventy-four years of age, and from the extracts here given it is apparent that he had devoted a great deal of thought to the problems of Eugenics, and the central idea that it would be advantageous to the community that marriages of men and women should be arranged so as to produce the best possible children is quite clearly and definitely stated. The means suggested in the *Republic* for bringing this about were not intended as a scheme practically applicable at his own day, and the most ironical of Greek authors must not be taken too literally.

Many of the details of Plato's scheme were

criticised by Aristotle in the *Politics*, a work also dealing with the art of government. But Aristotle, although a great naturalist and the son of a physician, is concerned more with the political than with the biological aspect of the question. He aims rather at securing good social and economic conditions than at improving the human breed. Thus when he advocated restrictions on the increase of population, it is principally on the ground that too rapid an increase would lead to inequitable distribution of property, and secondly, that overwhelming numbers cannot be reduced to order. He retains the family group on moral grounds, but is not afraid to claim for the State a vigorous control of its marriage arrangements. He is especially alive to the desirability of making the conditions such that the children born shall be as healthy as possible, and for this reason discountenances too early marriages. 'Marriage at a youthful age has a prejudicial influence upon the procreation of children. It is a law of the whole animal world that the offspring of youthful parents are imperfectly developed, are apt to procreate females, and are small in body, and we must conclude the same to be the case among human beings. We infer it from the fact that in all States in which the practice of youthful marriage is in vogue, the citizens are imperfectly developed and small in stature. Another

objection to such marriages is that young women are greater sufferers in travail, and die oftener.'[1]

He also expressed an opinion, which was shared by Pythagoras, and was in accord with Greek practice, that the winter is the best season of the year for marriage, and he recommends that 'The parents themselves, in view of the procreation of children, should pay attention to the rules of physicians and natural philosophers, the former of whom are competent authorities upon the occasions suitable to their physical condition, and the latter upon the various kinds of winds, northerly winds being in their judgment preferable to southerly.'

The following advice to mothers is unquestionably sound:—'Women should take care of their bodily health during pregnancy, not leading a life of indolence, nor yet adopting a scanty diet.' Aristotle suggested that they should be prevented by law from leading a life of too great indolence, for they should be compelled to take daily a 'certain walk to render service to the gods whose function it is to preside over child-birth.' As the temples of these divinities were placed for ceremonial reasons without the walls of many Greek cities, the constitutional prescribed would be of some length. He goes on to say that 'their mind . . . should be

[1] Weldon's translation of *Aristotle's Politics*.

at such a time comparatively indolent and *free from anxiety*, as we see that the children are affected by the state of the mother during pregnancy just as plants by the condition of the soil.'

One other writer, namely Campanella, should be mentioned before closing this chapter, because he is regarded by Havelock Ellis as the 'prophet of modern Eugenics.'

Campanella was a monk; he lived at the beginning of the seventeenth century, and while in prison wrote a book entitled *The City of the Sun*, in which, as in Plato's *Republic* and More's *Utopia*, an ideal state is depicted. To judge from the brief account of his work, which appears in Havelock Ellis's book, *The Task of Social Hygiene*, his ideas on Eugenics were taken almost directly from Plato. Only valorous and high-spirited men were to be allowed to procreate, and marriages, when made for the purpose of having children, were to be arranged by '"The Great Master," a physician aided by the chief matrons, and the public exercises of the youths and maidens, performed in a state of nakedness, were of assistance in enabling unions to be fittingly made.' The inspiration of Plato appears fairly obvious in this passage, and it is difficult to see that Campanella has improved materially on Plato's ideas.

SUMMARY OF CHAPTER

Eugenics and many associated problems are discussed in two of the works of Plato—namely, the *Republic* and the *Laws*. In the former the possibility of improving the human breed by the arrangement of suitable marriages, in something the same way as the breeding of horses and hounds is carried on, is discussed in a perfectly clear manner.

It is also suggested that marriages should be confined to persons of suitable ages, that those who were brave in battle should be rewarded by the quantity and quality of the fair placed at their disposal for matrimonial purposes, and that there was something to be said, on Eugenic grounds, against a system of medicine which enabled the weak and sickly to propagate their kind.

In the *Laws* it is proposed to place a tax on bachelors over thirty-five years of age. The special dangers of parental alcoholism are pointed out, and the advantages are insisted on of having the fullest opportunities for knowing as well as possible the people among whom one is going to marry.

Aristotle also, in his *Politics*, urges the desirability of arranging the conditions of marriage in such a way that the children born should be as healthy as possible.

The Eugenic ideas in Campanella's *City of the Sun*, which are described by Havelock Ellis, seem to be taken from those of Plato.

CHAPTER III

SIR FRANCIS GALTON AND THE SPREAD OF EUGENICS AT THE PRESENT DAY

Francis Galton was born near Sparkbrook, Birmingham, in the year 1822. It is worth while giving some account of his life, in order to show how wide and varied was the experience, and how thorough the knowledge of life which led him to found and further the study of Eugenics. His *Memories of my Life* is the principal source from which is derived the following information.

His paternal grandfather, Samuel John Galton, was a Quaker by religion, a banker and manufacturer by profession, and a scientist, naturalist, and statistician bv inclination. He made a considerable fortune, partly as a contractor for the supply of muskets to the army during the Napoleonic Wars.

On the mother's side his grandfather was Dr Erasmus Darwin[1], well known as a physician, poet, and philosopher, whose

[1] This information is derived from the *Dictionary of National Biography.*

poetical works dealt largely with natural history. One of them, called the *Botanic Garden*, included parts entitled *The Lives of the Plants* and the *Economy of Vegetation.* In his prose writings he propounded a theory of Evolution which had some points in common with that of Lamarck. Erasmus Darwin married twice; of his sons by the first wife, one, Dr Robert Darwin, was the father of Charles Darwin, the famous naturalist, who in his turn became the father of many distinguished sons. A daughter by the second wife, who married Samuel Tertius Galton, was Francis Galton's mother.

Samuel Tertius Galton was the eldest son, and carried on the banking business. He also had the taste for science and statistics shown by his father, and to a more marked degree by his son Francis.

Francis Galton's early education was of a literary kind, conducted by an invalid sister considerably older than himself; but at the age of eight he was sent to a school at Boulogne, which was 'hateful to him in many ways and lovable in none.' He stayed there for two years and then went on to a small private school at Kenilworth, from which, at the age of fourteen, he passed to King Edward's School at Birmingham. The education there was strictly classical. Grammar and the rudiments of Latin and Greek were taught, probably well, as many

good scholars were turned out from the school, but in a manner which failed to arouse Galton's interest. At the age of sixteen he left and embarked on the preparation for his chosen profession of medicine. The medical curriculum in the thirties and forties of last century was a very different thing to what it is now, particularly in that practical experience was obtained before the theoretical training. So Galton entered the Birmingham General Hospital as an indoor pupil; he found the work interesting, and being soon placed in a position of considerable responsibility as dispenser and dresser, often had many surgical cases at the same time under his care. The account of his experiences there gives one a very lively idea of the nature of surgical treatment at that time. After leaving the Birmingham hospital he went to King's College, London, where he remained up till the age of eighteen years, attending lectures on science, and studying medicine as a pupil at King's College Hospital.

In the spring of 1840 an ardent desire for travel seized him, and his father arranged that he should go to Giessen to attend the lectures of the famous chemist, Liebig. He soon found that his knowledge both of German and Chemistry was inadequate to enable him to derive any benefit from these lectures, and he set off alone to travel in the East as long as the money at his disposal would allow.

As an indication of the hardships and discomforts of travelling in the year 1840, even in civilised countries, it may be mentioned that on the homeward journey it took seven days and eight nights to reach Boulogne by diligence from Milan. From this some idea may be gained of the adventurous spirit and practical ability of a boy of eighteen who set out alone and accomplished a successful journey, extending as far from home and in such wild places as Greece and Asia Minor.

In the autumn, after his return, Galton went up to Trinity College, Cambridge, where his talents threw him into the society of all the best undergraduates of the day. Many of these afterwards attained distinction of various kinds in varying degree, as, for instance, Sir Henry Maine, Lord Justice Kay, and Tom Taylor. He showed here his talent for friendship and discriminating appreciation of the good qualities of his fellows, characteristics which more than any other prevent a clever man from turning into a crank and keep sane his outlook on the world.

But though taking such full advantage of the social opportunities which are among the principal benefits of a career at Oxford or Cambridge, Galton applied himself with very great energy to the acquisition of mathematical knowledge, with the unfortunate result that in his third year his health broke down, and he was obliged to take a long rest

and to abandon the idea of obtaining honours in mathematics. So after taking a poll[1] degree he attended lectures on medicine in Cambridge, and then went for a time to St George's Hospital in London. On the death of his father in 1844, Galton, not yet having fully recovered his health, abandoned his medical career and set out on further travels. The first place visited was Egypt, where with two companions he penetrated up the Nile as far as Khartoum, travelling by river to Korosko, then by camel across the desert to Abuhamed, and thence onward by boat. Khartoum was at that time much beyond the range of ordinary tourists.

From Egypt Galton went to Syria, and after returning settled in Leamington with his family, where he hunted and shot and fraternised with the hard riding and hard living set who formed the Leamington Hunt Club. From 1846–50 he spent much time in London, but he saw a good deal of other parts of the British Isles. For recreation he hunted with the Queen's Stag Hounds, took walks and riding tours, tried ballooning; while at the same time he did much serious reading, and invented a device called the telotype for printing telegraphic messages.

In 1850 he set out for a voyage of serious exploration in South-west Africa, which was

[1] A degree taken without honours, corresponding to the Oxford pass degree.

carried to a successful conclusion in the face of great hardship and difficulty. His success was recognised by the Royal Geographical Society, who, in 1854, awarded him one of their two annual gold medals. His experience of travel was turned to good account at the time of the Crimean War, in a course of lectures on camp life given gratuitously at Aldershot, to the officers stationed there. Our soldiers were at that time quite ignorant of the subject, but Galton's offer to the War Office thus to communicate his own experience received no answer from them till it was brought directly to the attention of the Prime Minister.

From that time onward Galton lived principally in London, and began there the pioneering work on various scientific problems which he kept up till the end of his long life. Meteorology was one of the first subjects which claimed his attention, and he enriched it by discovering and naming the anticyclone, an atmospheric system, the persistence of which was so heartily cursed in the summer in 1911, and so earnestly prayed for in 1912.

Geography he was always keenly interested in, and as a member of the Council of the Royal Geographical Society he came in touch with all the famous explorers of the day, and in his book tells much that is of great interest about their characters and quarrels.

But it is by his work on heredity and on

the subjects into which it led him, that Galton's scientific fame was principally gained. Stimulated by the publication of the *Origin of Species* in the year 1859, and 'impressed by many obvious cases of heredity among the Cambridge men' of his own time, he gave much serious thought and hard work to the subject, and published the first results in *Macmillan's Magazine* for 1865. The articles in question were called 'Hereditary Talent and Genius,' and besides treating of the subjects indicated by the title they contained his first utterances on Eugenics. We cannot follow in detail the subsequent stages of Galton's work on heredity, though some aspects of them will be dealt with in a later chapter. Here it may be noted that they gave rise to his inquiry into 'Human Faculty' and to the organisation of much anthropometric investigation. The measurement of the proportions of human beings, which is comprised in anthropometry, led him to the consideration of Bertillon's system for the identification of criminals, and then in turn to other possible methods of Personal Identification. As a result, he devised the fingerprint system which is now in use at Scotland Yard almost in its original form, and with some modifications has spread from England to many other countries.

While devoting so much energy to scientific work in so many fields, Galton was always the

very opposite of a recluse. He had ample opportunities and the power for making friends of all the men of distinction in his day, and he used them to the full. He attached great importance to the opinions of his friends, and consulted them freely about his scientific undertakings. He must be regarded as a man with a knowledge of men and things far beyond the ordinary, eminently receptive and inventive, and always in touch with life at a thousand points. His intellect was quite unclouded up till his death in 1911. He was no mere benevolent constructor of Utopias, but a man whose exceptional originality of mind was always guided by an equally remarkable experience of human nature and life.

As has been previously stated, Galton gave utterance to his earliest views on Eugenics in 1865, in two articles published in *Macmillan's Magazine.* Writing in 1908, he says: 'They expressed then, as clearly as I can do now, the leading principles of Eugenics.' He again referred to the question in his book on *Human Faculty*, in 1884, and there the word Eugenics was first introduced in describing as follows some of the objects of the work.

'Its intention is to touch on various topics more or less connected with that of cultivation of race, or as we might call it, with "Eugenic" questions.'

The nature of such qualities as energy and delicacy of sense-perception are investigated, and in certain cases an estimate of their value to the race is given.

Thus of energy Galton writes, 'In any scheme of Eugenics, energy is the most important quality to favour; it is, as we have seen the basis of living action, and is eminently transmissible by descent.'

Galton again returned to the subject of Eugenics in the year 1901, when he delivered the 'Huxley Lecture' before the Anthropological Institute, on the 'Possible Improvement of the Human Breed under existing conditions of Law and Sentiment.' This lecture, which was followed by others read before the Sociological Society a year or two later, aroused considerable public interest on the subject, which has since then continued to grow and spread.

In order to facilitate research into the many problems involved, Galton founded, in the year 1904, a Research Fellowship at London University. Early in 1905 the present writer was appointed to this post, and worked, partly under Galton's immediate direction, in a room rented by University College in Gower Street. Shortly afterwards a research scholarship was added, and filled by Miss E. M. Elderton. After the resignation, in 1907, of the first Research Fellow, the institution, originally called 'The Eugenics

Record Office,' was placed under the superintendence of Professor Karl Pearson, who had from the outset kindly and willingly responded to all requests for advice and help. Its name was changed from 'Record Office' to 'Laboratory.' Dr David Heron was then appointed Research Fellow, and from time to time other members of the staff have been added.

On Galton's death his residuary estate was bequeathed to form a permanent endowment of the laboratory. It was his wish that no part of the money should be spent on building, and that a professorship should be established which Professor Karl Pearson should be invited to hold. The latter accepted the position, so the result has been to place the laboratory on a much firmer footing, without involving any change in its personnel. Its activity has been indicated by the production of a long series of memoirs, many of them involving first studies of problems of exceptional difficulty. Some will be referred to in detail in subsequent chapters. Galton's foundation is essentially and almost entirely an institution for research; it does not directly aim at the spread of Eugenic ideals or even at generally diffusing such small knowledge of the subject as is at present available.

For the latter objects the Eugenics Education Society was founded in the year 1908,

and under the honorary secretaryship of Mrs Gotto has pursued since then an active career. The direction of its policy is in the hands of a council of forty members. Galton himself joined the Society as honorary president, while the acting president is now his cousin, Major Leonard Darwin.

The aim of the Society is principally to encourage people to think about Eugenics, and as a means to that end it holds meetings, at which different phases of the subject are discussed from many points of view. It publishes a journal entitled the *Eugenics Review*, the contents of which include many of the papers read before the Society, reviews and notes on much relevant literature, both books and periodicals, and reports of such Parliamentary and other proceedings as are of interest to Eugenists. It is, in fact, a very well-conceived and useful periodical.

The Society endeavours to examine by means of more or less expert committees the tendency of proposed legislation, in order to use its growing influence to support what is Eugenic and to oppose what is dysgenic. Its further activities include the organisation of lectures of various kinds to suit different audiences, and where occasion arises the encouragement of co-operative research.

It has branches in Belfast, Birmingham, Glasgow, Haslemere, Liverpool, Manchester, five in New Zealand, and one in Australia.

In 1911, at the instigation of this Society, the Congress of National Health at Dublin included a Eugenics Section, and during the summer of 1912 the first International Eugenics Congress was held in the buildings of the University of London. The Congress attracted more than 700 members, and as its proceedings were fully reported and sympathetically commented on by all the more reputable London papers, it must have had a wide influence in bringing the notion of Eugenics home to the public. Among the members of the Congress were many distinguished scientists and public men from the United States, Germany, France, Belgium, Denmark, Norway, Italy, and Spain, as well as from our own and many other countries, and its proceedings contained a great deal of interest and importance which will as occasion arises be more fully dealt with in this volume.

Another agency which has incidentally been instrumental in spreading ideas on Eugenics in this country is the National Council for Public Morals, which takes for its motto the following quotation: 'The foundations of National Glory are set in the homes of the people. They will only remain unshaken while the family life of our race is strong, simple, and pure.' Though this sentence implies that their object is 'National Glory,' they are really striving for something that is broader and of purer gold, even though

it may glitter less. One of their methods is the publication of a series of *New Tracts for the Times*, of which at least two advocate Eugenics as a means of accelerating a process styled by the National Council, with perhaps unintentional pessimism—'Race Regeneration.'

In other countries the idea of Eugenics is also spreading widely and rapidly. This is particularly the case in the United States.[1] Researches bearing directly on the subject have been carried out in that country from 1874 and 1875 onwards. Among the first of these was the investigation by Robert Dugdale of the 'Jukes' family, from which an inordinate number of criminals and other undesirables have sprung. Much evidence of a similar kind has been published in the proceedings of the National Conference of Charities and Correction and of the American Prison Association.

The inheritance of Deaf Mutism has also been systematically investigated since the publication, in 1883, of Dr Alexander Graham Bell's *Memoir upon the Foundation of a Deaf Variety of the Human Race.*

In addition to this early Research Work a propagandist proposal was made by Loring Moody of Boston in 1881. He suggested the

[1] The information concerning the spread of Eugenics in America is taken principally from an article in the *Quarterly Journal of Economics* (November, 1911), by Mr J. A. Field.

establishment of an Institute of Heredity, which, by means of providing lectures and a library, should diffuse 'knowledge on the subject of improving our race by the laws of physiology.' Death prevented Moody from realising his proposals, and it was many years before any idea of the kind was suggested again.

In 1903, probably owing to the enthusiasm for the scientific methods aroused by the re-discovery a year or two previously of Mendel's results, the American Breeders' Association was formed to acquire a knowledge of heredity for practical application in the breeding of plants and animals. In 1906, two years after Eugenics had found in England an official home at the London University, this Society appointed a committee on Eugenics, which, in 1910, was converted into an autonomous section. The chairman is Dr David Starr Jordan, author of *The Blood of the Nation* and *The Human Harvest*, both works dealing with Eugenics; and the secretary is Dr C. B. Davenport, director of the Department of Experimental Evolution of the Carnegie Institution at Cold Spring Harbour, Long Island.

The Eugenics section carries on its work of investigation by means of committees of experts, which it appoints to consider special problems. It has also established a Eugenics Record Office at Cold Spring Harbour, with

a permanent staff under the special superintendence of Mr H. H. Laughlin, the general direction of which is in the hands of Dr Davenport. The principal work of the office is the collection of pedigrees intended to elucidate the laws governing the inheritance of special mental and physical qualities in man.

That the idea of Eugenics has spread almost too rapidly among certain sections of the American public is shown by the passing of many laws of a rather hasty and ill-considered kind—a process for which the American Constitution appears particularly well adapted.

In Germany the aims of Eugenics are pursued under the title of Race Hygiene, which means the promotion of agencies for the betterment of future generations, different from, but analogous with, hygienic measures for the betterment of the existing generation. The German Society for Race Hygiene is grouped with societies having similar objects in other countries to form an International Association, which thus defines its aims[1]:—

ENDS AND MEANS

(I.) The International Association for Race Hygiene aims at promoting the theory and practice of Race Hygiene among white races.

[1] Translated from 4 *Bericht der Internationalen Gesellschaft für Rassen-Hygiene.* 1909.

(II.) The Association is unconnected with any political or religious movement.

(III.) The Association seeks to promote its purpose—

(*a*) By advancing scientific, racial, and social biology, including racial and social hygiene, and in particular by the collection and registration of those facts concerning the normal and pathological nature of body and mind, which are important in the study of variation and heredity in man.

(*b*) Through the spread of the knowledge that is acquired, as well as the practical guidance to be derived from it, among the members and among the people at large.

(*c*) By drawing closer together the members of the Society who are willing to regulate their own lives in accordance with the motives of the Society—firstly, by earnest efforts to keep themselves in good condition in body and mind; secondly, by pledging themselves to ascertain before marriage, according to the directions of the Society, whether they are fit for it, and if unfit, either to remain unmarried or to refrain from parenthood; thirdly, by promoting the individual and racial well-being of the rising generation.

The International Association for Race Hygiene consists of the German Society, which has branches in Munich and Berlin, and the Swedish Society for Race Hygiene; it has also individual members in many other lands.

In France, a committee was formed in connection with the International Congress, of which many of the members were men of world-wide reputation, as anthropologists, neurologists, alienists, statisticians, and students of heredity and medicine, and since then a permanent Society has been founded. Strong committees were also formed in Italy and Belgium. In Denmark a section of the Anthropological Committee has been appointed to consider eugenic questions, while as a result of the Congress, the study of Eugenics in Belgium has been placed on a firm footing by the establishment of a Eugenics Section at the Institut Solvay. It would be out of place here to give a complete account of this Institution, which has no parallel in any other European country; but in order that due significance may be attached to its latest step, it is necessary to give some sort of indication of its nature.

It was founded by M. Solvay in 1902, and established in a large and handsome building in the Parc Léopold at Brussels. Its object is to facilitate the study of sociology, which comprises all questions concerning the

structure, working, and evolution of society. Sociology includes on the one side industrial and economic problems, and on the other side the social applications of biology; the science of Eugenics may thus be rightly regarded as a branch of it. The instutute in question is equipped with a scientific and administrative staff, a magnificent library, and a bibliography of everything that appears on the subject of sociology. Its resources are at the disposal of persons engaged in making sociological researches, and in order to encourage work of this description prizes are offered yearly for investigations on particular problems.

In Holland a committee has been formed to urge the need of medical research before marriage, and 'To convince mankind that one is morally bound to ask for medical advice before marriage, which ought to be done, both in the interest of the inquirers and of the offspring.' The committee declares itself against interdiction of marriage.

In addition to the societies and institutions organised either wholly or partly for the advance of Eugenics, there are many movements on foot with objects which might be considered as Eugenic in their nature if they were pursued as parts of a larger scheme. Of these perhaps the two which have most importance are those intended to protect the young against the dangers which arise from

their own sexual life, and to shelter mothers during and after pregnancy.

SUMMARY OF CHAPTER

The widespread acceptance of Eugenics, if not as a practical policy for immediate application, at any rate as a proposition worthy of serious discussion is due almost entirely to the influence of Sir Francis Galton. Therefore, in order to show that his proposals were the fruit of an exceptionally ripe and varied experience, it seemed desirable to preface an account of the agencies now at work for the spread of the idea, by a short summary of his ancestry and life with an outline sketch of his work and character.

The development of the Galton Laboratory for Eugenics at the London University is next described as the only establishment in this country devoted to the carrying out of statistical researches on the subject. After some mention has been made of the Eugenics Education Society, The American Breeders' Association is dealt with in relation to its work on Eugenics. The objects of the International Association for Race Hygiene next receive attention, and finally the establishment of a Eugenics department at the Solvay Institute for sociology at Brussels is referred to.

CHAPTER IV

EVOLUTION AND EUGENICS

HEREDITY finds its commonest outward expression in the fact that characters or qualities observed in the parents frequently occur also in the children. In everyday language the child is said to take after his mother or his father. He sometimes also takes after his grandmothers or grandfathers, or even after relations of more remote degree in his direct ancestry. In some respects he may favour (to use another colloquialism) some uncle or aunt or other collateral, and the resemblance may be either general or particular. It cannot be too emphatically asserted that what is observed is not the inheritance of particular characters,[1] but the similarity in respect to them of two individuals belonging to the same family. Heredity is the hypothesis put forward to explain this similarity, or, to speak more precisely, to label it as a particular instance of general law.

The scientific study of heredity appears to turn about two problems, one descriptive and the other physiological. We want an

[1] The word character is here used in a technical sense, denoting qualities or characteristics, mental and physical.

accurate and precise account of the facts—what characters are inherited, and to what degree and in what way they are inherited; and we want to find out the nature of the underlying mechanism. It is obvious that these two problems are in reality so closely connected as to be practically one. For a knowledge of the facts is the only guide to the mechanism, while an understanding of the mechanism more than anything else would help one clearly to realise the facts. Of the many theories which have been put forward as to the essential mechanism of heredity, one only has stood the test of time, and this is held by practically all biologists at the present time. This is the theory of the 'continuity of the germplasm' propounded by August Weismann about thirty years ago. When it is said that Weismann's hypothesis is almost universally accepted at the present day, its broad outline is referred to, and not the elaborate detail with which the outline was originally filled in. The detail need not here be described, but a knowledge of the essentials is indispensable to a thorough study of Eugenics.

The 'germplasm' is the material out of which the germs are made, the germs themselves being the elements which under suitable conditions grow and develop into the adult animal or plant. It is the nature of the germplasm which determines what kind

of animal or plant shall spring from the germs, not only in respect to those broader differences which characterise the species and variety to which it belongs, but also to a large extent in respect to its individual characters.

Now as each creature proceeds to develop by the growth and differentiation of that small mass of germplasm which apart from some provision of food and covering was its all at the first beginning of individual existence, a portion of that same mass is set aside unchanged in quality though increasing in quantity. The particular function assigned to this reserve of material, which forms no true part of the body in which it lives and grows, is to provide the germs from which the succeeding generation shall spring. In the members of that next generation a similar process occurs, and thus it can truly be said that the germplasm is continuous from one generation to another. If it is the nature of the germplasm which determines the growth and development of the individual, and if the father, son, and grandson on the one hand, and the father's father and father's grandfather on the other, all spring from different portions of the same germplasm, then the similarity between them can be more readily understood than the differences.

The fact that the reproduction of the more conspicuous of the animals, and to a lesser

degree of the plants, is largely sexual—that is to say, that the germplasm in each case is provided, one-half by the father and one-half by the mother, complicates, but does not alter the essential nature of the theory. In particular, it leads to the following inference—that each portion of the body must be represented in duplicate in the germplasm, from which it follows, further, that characters represented potentially in the germplasm need not be developed in the actual body.

It will be as well to introduce here the word 'soma,' borrowed from the Greek to denote the body contrasted with the germplasm. From it is derived the expression 'somatic characters,' denoting the actual characters of the body, when it is necessary to distinguish clearly between them and the characters existing potentially in the germplasm. The latter may be called the gametic characters, a term the meaning of which will be explained later. We have at present no knowledge of their real nature. We cannot tell whether it is a difference of chemical constitution, of the architecture and arrangement of the component parts, or of their motions relative to one another which decides that one microscopic fragment of germplasm shall unfold into a small mouse with white hair, pink eyes, and the habit of running round after its tail, and another into a tall senior wrangler.

Such knowledge is necessary to the complete understanding of heredity; it is not essential to the acceptance of the theory of the continuity of the germplasm. The importance of this theory to the biologist consists not only in the simplicity of the explanation which it affords of some of the phenomena of heredity, but also in its bearing on the two principal hypotheses which have been put forward to account for the now generally admitted fact of organic evolution. At the present day hardly any one doubts that all the complex forms of life which we know, in their infinite variety, have arisen gradually from very simple beginnings, or that this progress which we call evolution is due in part at any rate to the operation of natural laws, without the interference of any miracle; what these natural laws are, and how they have operated, the framers of the two hypotheses referred to above have endeavoured to set forth. A study of evolution in the past would obviously assist those who desire in some small way to regulate it in the future. It is thus desirable to examine briefly the chief explanations which have been offered. The first of these, in point of time, was propounded by Lamarck.

Jean Baptiste de Lamarck[1] was born in

[1] The account of Lamarck and his views has been largely taken from Morgan's *Evolution and Adaptation* and from Weismann's *Evolution Theory*.

Picardy in the year 1744. He was first a soldier, secondly a botanist, and thirdly a zoologist. As a botanist he published a flora of France, as a zoologist he defined and named the great division of the animal kingdom called Vertebrates (animals with backbones).

His theory of Evolution was given full utterance to in the *Philosophie Zoologique*, which he brought out in the year 1809. It consists essentially of four propositions.

First, that the simplest organisms were produced in the past, and are constantly being produced in suitable localities and under suitable conditions by the process of spontaneous generation. At the present day an overwhelming majority of biologists consider it proved that unorganised matter does not spontaneously change into living beings. They accept the dictum '*omne vivum e vivo*'—that every living thing is produced by another living thing, though they concede the possibility postulated by a thorough-going acceptance of the theory of Evolution that in primeval times when the physical conditions of the earth were very different from what they are now, living matter may have been evolved gradually from inorganic beginnings.

His second proposition is that the direct action of a changing environment has produced lower animals and plants of diverse forms, from the simple organisms arising in the manner described above. This is a

purely formal explanation, it does not help one in any way to understand the facts.

Thirdly, that among the higher animals the diverse forms and structures have been caused indirectly by changes in their surroundings according to the following 'laws':—

(I.) 'In every animal that has not passed beyond the term of its development, the frequent and sustained use of an organ strengthens it, develops it, increases its size, and gives it strength proportionate to the length of time of its employment. On the other hand, continued lack of use of the same organ sensibly weakens it; it deteriorates, and its faculties diminish progressively until at last it disappears.

(II.) 'Nature preserves everything that she has caused the individual to acquire or to lose by the influence of the circumstances to which the race has for a long time been exposed, and consequently by the influence of the predominant use of certain organs (or in consequence of continued disuse). She does this by the generation of new individuals which are produced with the newly acquired organs. This occurs provided that the acquired changes were common to the two sexes and to the individuals that produced the new forms.'

The essential propositions of this third division of the theory may then be briefly stated in the following manner:—Changes

in the animal's surroundings are responded to by changes in its habits. Any particular habit involves the regular use of some organs and the disuse of others. Those organs which are used will be developed and strengthened, those not used diminished and weakened, and the changes so produced will be transmitted to the offspring, and thus progressive development of particular organs will go on from generation to generation.

As examples of the action of these supposed laws, Lamarck instances the long legs, long necks, and long bills of wading birds, such as herons and storks, acquired gradually by the practice of wading first in shallow and then in deeper and deeper waters in their search for fish. A terrestrial parallel is provided by the giraffe, who feeds on the foliage of trees and, by continually stretching upwards to seize and devour it, has succeeded in lengthening his forelegs and almost more conspicuously his neck, so that now he can browse on lofty branches without discomfort. As examples of the way in which organs may degenerate through want of exercise continued through many generations, we have the loss of legs in the snake, brought about by its habit of wriggling through the grass, and the loss of teeth in the whale, incurred after it gave up a fish diet and took to bolting myriads of minute animals without masticating them.

The most notable exponent of Lamarck's theory in a modified form was Herbert Spencer, and some of the questions which it involves were debated with great vigour by him and his principal opponent, August Weismann. The chief objection to the theory is that if the effects of the environment on the individual, such as the special development of organs from sustained use, are in fact transmitted to the offspring in the ordinary course, it ought to be easy to obtain direct evidence of it, yet when one comes to inquire one finds that evidence is wanting. The theory of the continuity of the germplasm is opposed to the Lamarckian view, because it is difficult to conceive how by stretching his neck the ancestral giraffe could have so affected the germplasm as to produce a longer neck in his offspring, if one remembers that it was separated out and put in reserve long before he took to vegetable food, and even before he had designs on his mother's udders.

The theory of natural selection now to be described affords a much more easily understood interpretation of the giraffe's neck or any other adaptation to the environment than does that of Lamarck. The two are not, however, necessarily in antagonism. Darwin himself believed that the effects of use and disuse might be inherited, and even in expressing his conviction that natural selection has been the most important factor in evolution,

clearly indicates his belief that it was not the only one. The theory of natural selection was enunciated by Darwin and by Alfred Russel Wallace at the same time in papers read before the Linnean Society on July 1, 1858, and was stated more fully by the former in the *Origin of Species*, which appeared first in 1859. In the historical sketch which forms an introduction to this work, its author gives credit to Dr Wells for having enunciated the principle as early as 1813. Dr Wells did not, however, see in it a possible cause of Evolution, but merely a hypothesis to account for some of the characteristics of the different varieties of mankind. The theory of natural selection is so well known that an account of it may seem superfluous, but it is often misunderstood, and to many is known only by name; thus for the sake of completeness it will be stated here as briefly as possible.

All animals and plants reproduce their kind at such a rate that if nothing occurred to check their multiplication the offspring of a single pair could in a limited time cover the face of the earth. Thus the elephant is the slowest breeder of all animals, but in 740 or 750 years a single pair of elephants might produce nineteen million descendants, while it has been calculated that in less than this period a single pair of house-flies could give rise to a mass of descendants many times the size of the earth. A taste for arithmetic

assisted by a table of logarithms would enable any one who knew the elementary facts about the breeding habits of a few particular species to obtain many such sensational results, but better evidence is forthcoming concerning the rapidity with which plants or animals may multiply under favourable conditions. For example, in England the rabbit barely succeeds in maintaining its numbers, yet when a few specimens were introduced into Australia in a very short space of time their progeny became so numerous as to be a serious plague.

From a consideration of these facts it follows that under normal conditions not all these individual animals and plants which come into existence reproduce their kind. In many cases the proportion of those who do so is a very small one. What then are the circumstances which prevent the remainder from so doing? It is unnecessary to answer this question in great detail, and it would be impossible, for the answer would be different in each particular case; but one may say generally with regard to wild animals, in the first place, that they may fall a prey to others which live on them; secondly, they may not be able to withstand climatic conditions, such as the severity of the winter or the heat and droughts of the summer; thirdly, in times of scarcity there may not be enough food to support the life of all, and many may starve.

The life of each is a continuous struggle, though often an unconscious one. Individuals compete with individuals, whether of the same or of a different species, and social groups conflict with other social groups, and species with species, while each and all must protect themselves against the attacks of inanimate nature. This baldly stated is what is meant by the 'struggle for existence.' Plants, no less than animals, feel its effects, for only those which can provide themselves with the necessary food and are able to maintain life through any conditions which occur can have any chance of reproduction.

That a struggle for existence of such a kind as has been described is one of the facts of life in wild nature can hardly be disputed, and, granting that variation occurs, it is not easy to dispute that those who do succeed in producing offspring must be on the whole the better adapted in structure and habits to the circumstances under which they live. Thus it results that the 'struggle for existence' leads to the 'survival of the fittest.'

At this point a word or two must be said about the variation postulated. Variation means the appearance in a species of individual differences—'the many slight differences which appear in the offspring from the same parents, or which it may be presumed have thus arisen, from being observed in the individuals of the same species inhabiting the same confined

locality, may be called individual differences.'[1] 'We see indefinite variability in the endless slight peculiarities which distinguish the individuals of the same species, and which cannot be accounted for from inheritance from either parent or from some remote ancestor.'[2]

The theory of natural selection offers no explanation of the cause of variability, it merely presupposes that there are differences such as those referred to in the quotations given above. If one admits this, which cannot be denied, one may further admit that some will be of advantage to their possessors in adapting them to the conditions under which they live and other disadvantageous. It then follows that the individuals whose peculiarities are of the former kind will be better adapted to their environment, better able to obtain food, to protect themselves from heat and cold, or from the assaults of their enemies. Where the competition is keen and none can rely on another's assistance, it needs little imagination to see that these will be far more likely to arrive at maturity, to take a mate and to leave a numerous progeny, than those who are less well adapted.

The next proposition to be considered is that some individual differences are inherited. This also can hardly be controverted, nor that among the inherited differences will be many that are of an advantageous nature;

[1] *Origin of Species*, Chapter II. [2] *Ibid.*, Chapter I.

if this is the case, and if each generation is derived rather more from the better than from the worse qualified members of the preceding generation, it follows that successive generations will become on the whole better and better adapted to their conditions of life, though this adaptation may be along divergent lines.

Let us return again to the contemplation of the giraffe. To understand how its peculiar form may be attributed to natural selection it is necessary to form some sort of mental image of the conditions under which its ancestors lived. They were vegetarians, and thus required a large volume of food. We can picture them living on grassy plains dotted with a few trees and shrubs. There would have been other animals about, some of them may have specialised in the art of eating grass, while others may have bared all such shrubs which were not themselves adapted to withstand such depredation. We must suppose that there was not enough food for all, and that the majority were in an almost constant state of hunger; but that some, by being longer and stronger in the neck than their brothers, were able to reach up among the lower branches of the trees, and from time to time eat their fill. Superior vitality, derived from the enjoyment of a relatively ample diet, would have given the long-necked ones a slight advantage over

the rest. In times of famine they would have been the last to starve; in fighting for a mate, the advantage would have been theirs; in flight from a carnivorous foe, theirs would have been the better chance of escape.[1] Thus their progeny would have been more numerous than that of the rest, and, granted that the long, strong neck was inherited, would also have had longer and stronger necks. The same process repeated indefinitely would have caused the average length of neck gradually to increase until a point was reached at which any further increase would either have conferred no additional advantage or would have been incompatible in some way with the general economy of the body.

This explanatory instance has been purposely described in a very crude way, the conditions of life being pictured as being far less complex than they really must have been. A complete description would be less easy to follow but more convincing. In this instance the Darwinian explanation may seem less direct and less probable than the Lamarckian; it is, however, unquestionably more in accord with the facts of heredity,

[1] It may occur to some to remark that a fat well-fed animal does not run as well as a lean one in good condition; to them I would answer that animals in a wild and unprotected state are always compelled to take sufficient exercise, and that food is never so abundant as to allow of habitual excess.

as we know them, and is perfectly in accord with the doctrine of the continuity of the germplasm. For it does not presuppose that changes produced in the soma by the action of the environment so alter the germplasm that similar somatic changes are more likely to occur in the next generation, but rather that the variations on which natural selection works are themselves produced in the first instance by variations in the germplasm and thus *ex hypothesi* inherited.

The question of the origin of variations in the germplasm is an interesting and perplexing one. Dr Archdall Reid has made the ingenious suggestion that here also the workings of natural selection may be detected, for the possession of a variable germplasm would be in itself an advantage to a stock, if not to an individual, in that it would allow selective adaptation to occur. But although this idea may show how variability may be developed it does not really explain how it arose in the first instance. It would seem probable that the direct action of environment must have been the operative cause both of general variability and sometimes also of specific changes which may manifest themselves by the appearance of certain somatic modifications in the offspring.

Darwin believed that Evolution through natural selection was brought about by the accumulation of small variations of the kind

that are constantly occurring. He recognised the appearance from time to time of 'monstrosities,' that is to say, individuals who differed in some respect markedly from all their fellows, but was of opinion that even if the difference exhibited were highly advantageous, although it might at first be preserved, 'it would generally be lost by subsequent intercrossing with ordinary individuals.' At the present day a school of considerable importance holds a different view. They recognise two kinds of variations. The small individual differences, the occurrence of which is called 'fluctuating variability,' and the larger differences, corresponding to some extent to Darwin's 'monstrosities,' which are called 'mutations,' though it is admitted that mutations need not necessarily be of a conspicuous kind. The inheritance of the former is denied, but the Mendelian theory, which will be described later, suggests the means by which a mutation occurring in a single individual may be transmitted without being swamped by intercrossing, and if of conspicuous advantage may spread rapidly through a population.

The principle of natural selection is equally acceptable whatever view may be taken of the nature of the characters selected; it acts invariably by establishing a differential birthrate which brings about a relative increase of individuals possessing certain qualities.

The differential birth-rate may in itself be due to differentiation either of the death-rate or of the marriage-rate. The latter in its turn may be due to a special form of selection called 'sexual selection.' Darwin describes sexual selection in the following words:[1] 'This form of selection depends not on a struggle for existence in relation to other organic beings or to external conditions, but on a struggle between the individuals of one sex, generally the males, for the possession of the other sex. The result is not death to the unsuccessful competitor, but few or no offspring. Sexual selection is, therefore, less rigorous than natural selection. Generally, the most vigorous males, those which are best fitted for their places in nature, will leave most progeny. But in many cases, victory depends not so much on general vigour, as on having special weapons confined to the male sex. A hornless stag or a spurless cock would have a poor chance of leaving numerous offspring. Sexual selection, by always allowing the victor to breed, might surely give indomitable courage, length to the spur, and strength in the wing to strike in the spurred leg, in nearly the same manner as does the brutal cock-fighter by the careful selection of his best cocks.'

Competition for a mate does not necessarily take the form of trial by combat. The

[1] *Origin of Species,* Chapter IV.

conscious or unconscious preference of the female for males in whom certain characters are especially developed would tend to further their propagation. And males also may exhibit and act on preferences for certain classes of females.

The influence of sexual selection in mankind at the present day would form an interesting study in Eugenics, and one which might be of practical importance. Sexual selection, guided by the eugenic ideal rather than by sordid desires, would seem the surest way of effecting racial improvement. No more need now be said on this point, for the theme will be more fully developed in a subsequent chapter.

Variation is shown not only in structure but also in habits and instincts. Where these are of a suitable character they may be as conducive to success as any structural peculiarity. The advantages derived by those who act on the maxim that 'union is strength' have thus led to the evolution of gregarious animals, who form social groups for mutual protection. These may compete with other social groups, with the result that good organisation, rather than the strength or cunning of all the individuals composing it, becomes the determining factor in selection. A successful group increases in size and spreads, it becomes split up into competitive sub-groups, which may again

fuse and again subdivide, while in each division competition among individuals may go on continually.

The gregarious habit leads to the development of certain qualities of mind which conduce to the smooth working of social life. These manifest themselves in the protection of individuals who are unable to protect themselves. In man the struggle for existence among the members of civilised societies in so far as it implies competition for the necessaries of life has almost stopped. Society provides food, shelter, and clothes for all who want them. Qualities such as vigour of body and mind may give a particularly favourable chance of reproduction to their possessors, but the opportunities for those who are relatively lacking in these qualities are almost equally favourable, and are more fully seized by them, owing, maybe, to their deficiency in thrift, foresight, and self-control. This state of affairs is regarded by some as a cessation of natural selection, and by others as natural selection grown harmful. It is immaterial which view we take. What has happened is this: that in so far as the social habits and the progress of the arts which depend on them have succeeded in adapting the environment to man, natural selection being altogether a slower and more wasteful process is no longer operating to adapt man to his environment.

Enough has been said to describe the essential features of the Lamarckian and Darwinian theories of evolution.

From the point of view of the humanitarian, their particular interest lies in their relevance to the consideration of the forces able to mould society at the present day. The idea of Eugenics arises almost as a necessity from the theory of Evolution by Natural Selection. If we recognise that Selection has led to such great changes in the past, we must believe it can do so in the future. Having realised this, it should be our endeavour consciously to control it so that the changes produced will be to our benefit. In so far as we do so we shall replace Natural Selection by an artificial selection, and some see a danger in this. They argue that Natural Selection leads to the survival and consequent multiplication of the fittest, and thus conducing to desirable results should not be interfered with. The fallacy in this position has been exposed again and again. It lies in the fact that in this type of argument the word 'fit' is used in two different senses.[1] When one says that Natural Selection is the survival of the fittest, one means merely that those who survive are the fittest to survive; that they are adapted to their environment, or their environment is adapted to them in such a

[1] Among others, Mr Balfour, in speaking at the Banquet of the International Eugenics Congress, pointed this out.

way that they have and use the chance of increasing and multiplying. This is the true meaning of the word fitness when it is used in discussing the theory of Natural Selection. But in ordinary language the word has quite a different significance: it means in good condition or of good quality, physical and mental, as a continued effect of nature and training; it suggests a sort of biological ideal of what a man should be. Now, Eugenists want to increase the numbers of those who are fit in the latter sense, but they do not think that Natural Selection as it works amongst mankind at the present day is likely always to help them, since the fit in the former sense may include many undesirable types, therefore they urge the introduction of artificial selection, where it is practicable under 'existing conditions of law and sentiment.'

Other groups which desire and are working for the same ultimate object, base their efforts on the Lamarckian rather than on the Darwinian theory of Evolution. They believe that progressive improvement in human life may be rendered possible simply by improving the conditions of life. Perhaps those who hold these views should also be called Eugenists. They would then have to be labelled as Lamarckian Eugenists to distinguish them from the Darwinian Eugenists, of whom Sir Francis Galton, the founder of the Science, was one.

Though the majority of persons who give the subject a thought attribute the wide variety of habit and structure exhibited by animals and plants to the work of evolution, it is probable that the old and highly respectable theory of 'special creation' still survives. It has the merit of being so simple as to require no thought or knowledge for its understanding, and so devoid of any basis of reason as to be quite unassailable by argument. It is true that a series of fossil organisms gradually increasing in complexity are found as one explores first the older and deeper strata then those more shallow and more recent; it may be urged that this would appear to conflict with the notion that in a certain week of the year 4004 B.C. all the myriad species which we now recognise were established in the present form by the creative act of the Deity, but the thorough-going creationist has two alternative answers ready to meet any objections raised on these or similar grounds. First, 'when God made the rocks He made the fossils also.' Secondly, 'the devil made the fossils in order to tempt mankind into propounding and believing in the heretical and soul-destroying fallacy of Evolution.'

In recent years churchmen have for the most part frankly accepted the teachings of science, and Evolution is no longer a ground of conflict between science and religion; but

the special creation theory still appears to linger on. In particular, it is implied in the view that all babies are equal by nature at birth, and only become different subsequently owing to the action on them of different environments. This is a view on which many social reformers appear to act, but it is incompatible with the acceptance of any theory of Evolution.

SUMMARY OF CHAPTER

The theory of the 'continuity of the germplasm' is now generally accepted as a general description of the mechanism by which the resemblances shown by members of the same family to one another, in so far as they are due to inheritance, are brought about. In the case of sexual reproduction, each individual receives a portion of germplasm from his father and another portion from his mother. All the characters of body or mind which he develops during his life are determined partly by the nature of this germplasm and partly by the action of the environment. Very early in the life of the individual a portion of it is set aside, and takes no part in the building up of the body. It increases by growth, and is divided up and stored in sexual cells, from which in turn fresh individuals of the next generation are produced. Thus each individual springs from the germplasms which gave rise to its father and

mother, and as the germplasm must be the principal factor in determining the characters of the body, it follows that children must tend to resemble their parents, brothers and sisters, and other relatives, since they are derived to a greater or less extent from the same germplasm.

Theories of organic evolution endeavour to explain how by the operation of natural laws the countless forms of life, with all their individual complexity, may have been evolved from something comparatively simple. There are two principal theories of Evolution. The earlier is that of Lamarck, which attributes it largely to the inheritance of the effects of the use or disuse of certain organs or modifications of the body produced by the direct action of the environment. The Theory of Natural Selection by the survival of the forms better adapted to their surroundings in the struggle for existence, propounded by Charles Darwin and Alfred Russel Wallace, is the other. The facts of heredity as we know them are more in accordance with the latter than the former. So is the theory of the continuity of the germplasm. It would be quite conceivable that the inheritance of the effects of use and disuse should have aided Natural Selection, but the evidence available hardly favours this view. On the other hand, there is a very strong probability that Natural Selection is one

of the causes of Evolution, if not its only cause.

Any endeavour to improve progressively the mental and physical qualities of mankind must, consciously or unconsciously, model itself on some theory of Evolution. Those who would strive to do this merely by the improvement of the environment try to establish a parallel to the process described by Lamarck. They may be called Lamarckian Eugenists. Those who, following Sir Francis Galton, rely on the exercise of conscious selection applied by any means practicable under existing conditions may justify their view by an appeal to Natural Selection. Others, again, make no endeavour to effect a progressive improvement, but believing that the species is immutable, aim only at making the circumstances as favourable as possible for the development of the immediate generation. These have no biological basis on which to work but the theory of Special Creation.

CHAPTER V

MENDELISM

THE study of inheritance in recent years has been pursued vigorously along two different paths. First, by the statistical summarisation of the facts, a process introduced by Sir Francis

Galton; and, secondly, by the experimental hybridisation of animals and plants. The latter method, when carried out on the lines laid down by Gregor Mendel, has alone led to some real understanding of the underlying physiological processes, and it appears capable of leading to more.

Our consideration of heredity, the central problem in Eugenics from which all the others radiate, will therefore be initiated with an account of Mendel and his work.

Gregor Johann Mendel was born in Austrian Silesia in 1822, the birth-year also of Sir Francis Galton. He entered the monastery at Altbrünn in 1843, but left it for a time to study physics and natural science at Vienna in 1851-3. For a time he taught in the school at Brünn, but afterwards became abbot of the monastery. He died in 1884.

His papers on plant hybridisation, which form the basis of the science of Genetics, were read before the meetings of the Brünn Naturalists' Society in 1865 (the year in which Galton first expressed his views on Eugenics), and published in their journal. They were neglected till 1900, when they were independently discovered, and the experiments repeated by Correns, Tchermak, and De Vries.

Mendel selected pea plants for hybridisation for two reasons: first, that the different varieties have constant distinctive characters;

and, secondly, that it is comparatively easy to ensure that no other pollen but that desired by the experimenter shall be used for fertilising them. It is not necessary to give a complete description of his experiments, for the principles ascertained from them can be clearly understood by studying one or two. As an example may be taken, the crossing of a tall variety of pea in which the plants grow normally to a height of six feet with a dwarf variety averaging about $1\frac{1}{2}$ feet in height. As it is necessary to be able to refer definitely to each generation produced in an experiment of this kind, a simple nomenclature has been devised for the purpose. The original pairs, are called the parental generation, abbreviated into P. The plants which are raised from the seeds which they set, are the first filial generation, F_1; the seeds of the F_1 generation grow into the plants of the second filial generation, F_2, and so on.

In this case all the plants of the F_1 generation were tall, in spite of the fact that one of the parents was a dwarf; there were no intermediate forms. Self-fertilisation was allowed to occur, the ovules of each flower being fertilised by its own pollen, and seeds were set. These in turn were planted and grew up into the F_2 generation. Plants were thus raised, of which 787 were tall and 277 dwarfs. Thus dwarf plants which disappeared in the F_1 generation reappeared again in

about a quarter of the plants of the F_2 generation, and in experiments in which different pairs of characters were crossed the same thing happened. The proportions varied slightly, sometimes being a little more than three of the one kind to one of the other, sometimes a little less, as would naturally occur if the plants actually grown were samples chosen at random from a very large number in which the two forms were accurately mixed in the proportion of three to one. The dwarf plants which reappeared in the F_2 generation were again self-fertilised and bred true to that character through all succeeding generations; that is to say, their immediate descendants were all dwarfs, and tallness did not again reappear in the stock. Of the tall F_2's, one-third bred true to this character, giving rise when self-fertilised only to tall plants. That is to say, that two groups, each consisting of one quarter of the whole number of plants produced in this generation, of which one was tall and the other dwarf, bred as true to these characters as the strains which were crossed in the first instance. The other half were all tall, but when self-fertilised did not breed true but behaved like the plants of the F_1 generation, giving again one-quarter dwarf and three-quarters tall.

As the latter character in the original cross seemed entirely to dominate the former, it was called the dominant character; while

the former, which disappeared in F_1, then reappeared in a quarter of the plants of F_2, received the name of recessive. All plants showing the recessive character bred true, but those with the dominant character were of two kinds, the one, the pure dominants breeding true, while the other, sometimes called impure dominants, behaved like the original hybrids. The whole process can be shown schematically much more clearly than it can be described in writing. Let T stand for tall plants which breed true, T(D) for tall plants which do not breed true, and D for the dwarfs. Let us suppose that one T is crossed with a D. Then the F_1 generation will all be T(D). Let us take one of these and trace out what its descendants will be on the supposition that it is self-fertilised and sets four seeds, which grow into healthy plants, and that these and each plant of subsequent generations are also self-fertilised and set four seeds. Then the pedigree will be as follows :—

	Generation.
T × D	- P
T(D)	- F_1
T 2T(D) D	- F_2
4T 2T 4T(D) 2D 4D	- F_3
16T 8T 4T 8T(D) 4D 8D 16D	- F_4
64T 32T 16T 8T 16T(D) 8D 16D 32D 64D	- F_5

FIGURE 1.

Thus far we have merely endeavoured to describe what happens; it is now necessary to examine the explanation which has been offered of the facts. Mendel's original interpretation will not be referred to, as another has been put forward in recent years, which is essentially the same in principle, is much more easy to understand, and accounts for a wider range of facts.

In sexual reproduction, male and female contributions of different outward form, but equivalent as agents for inheritance, unite to form the *zygote* which by its growth and differentiation is converted into the adult animal or plant. The two elements which thus unite are called *gametes*, a word derived from the Greek, and suggesting an analogy between the fusion of the gametes and marriage. The essential part of the gametes is the germplasm.

To turn from these definitions to the concrete instance of the tall and dwarf peas. The theory supposes that tallness is represented in all the gametes produced by a true breeding pea which displays it, by a single indivisible *factor*. It is not necessary in order to understand the theory to have any idea what may be the ultimate nature of the factor. It is further supposed that dwarf peas produce gametes in which this factor is invariably absent. Thus when a fresh zygote is formed by breeding together any

two peas belonging to these two classes it may be of three different kinds.

(1) The tallness factor may be included in the gametes of both parents, in which case the zygote may be called *duplex*[1] in respect to it, a word which is intended to signify that it contains the factor twice over.

(2) The factor may be brought in only by one parent, in which case the zygote is called *simplex*.

(3) Neither of the two gametes may contain it, and then the zygote is called *nulliplex*.

In all cases of Mendelian inheritance, individuals which are duplex with regard to a particular factor display the character which is represented in the germplasm by that factor, and nulliplex individuals the character which is developed in its absence. In the case we are considering, and in all cases in which the one character is dominant over the other, the presence of a single dose of the factor in the zygote is sufficient to bring about the development of the factorial character. It is thus displayed by all the simplex individuals. In other cases there may be no dominance or incomplete dominance; in other words, simplex may be intermediate in

[1] These terms were introduced by Dr C. B. Davenport. According to the older terminology, both duplex and nulliplex forms are described as homozygotes, because similar gametes unite to form the zygote. Simplex forms are styled heterozygotes.

character between duplex and nulliplex, or be entirely different from either.

Duplex individuals produce only gametes which contain the factor; in the gametes of the nulliplex it is invariably absent, while in one half the gametes of the simplex it is present and in the other half absent.[1] Let us consider what happens in the event of self-fertilisation in a pea which is simplex with regard to the tallness factor. Let those of its gametes which have the factor be written T, and those which do not possess it *t*. For the present purpose we may regard the ovules and pollen grains as the male and female gametes. Then half the ovules and half the pollen grains will contain the tallness factor and half will not, and every 100 ovules fertilised will probably consist of 50 T and 50 *t*. Each of these may be fertilised by a pollen grain T or a pollen grain *t*. Thus, according to the law of probability, half the 50 T ovules will be likely to be fertilised with T pollen grains and half with *t* pollen grains, and the zygote formed from them may thus be written 25 TT + 25T*t*, similarly from the 50 *t* ovules 25 *t*T zygotes + 25 *tt* zygotes will be developed.

The TT zygotes are duplex. The *t*T do not differ from the T*t*, and are simplex,

[1] The case would not be altered if, instead of self-fertilisation, fertilisation by another individual with the same gametic constitution took place.

while the *tt* are nulliplex. Therefore, according to the hypothesis, if two simplex individuals are bred together, one half of the offspring will be simplex, one quarter duplex, and one quarter nulliplex. An enormous number of experiments performed on a large variety of animals and plants have shown that this actually occurs. Thus the theory does in reality provide an adequate explanation of facts of this kind. It may also be checked by slightly varying the experiments.

To take an example from studies in inheritance of coat colour in mice. In this case the assumption is made that pigment is formed in the hair and eyes, if a pigment-producing factor is present in the zygote. When it is absent, no pigment is formed, and the mouse which lacks it is an albino with white hair and pink eyes. If the gametes containing the factor are written C, and those not containing it are written *c*, then the gametic constitution of an albino mouse is always *cc*, but that of a coloured mouse may be either *c*C or CC. The nulliplex *cc* when bred together will always produce albinos, and nothing but albinos, and the duplex CC produce nothing but coloured mice; but when the simplex *c*C are mated with one another, one quarter of the offspring are albinos.

Very numerous experiments, including some performed by the present writer, have demonstrated the truth of the facts. Now

let us suppose that the simplex forms are bred with albinos instead of among themselves, what will be the result? According to the theory, half the gametes of the simplex will be C and half *c*, whereas all the gametes of the albinos will be *c*; therefore, half the number of young mice produced ought to have a gametic constitution C*c*, and the other half *cc*. All the former class should have coloured coats and dark eyes, and all the latter white coats and pink eyes, and this is what acutally occurs.

The most important of the Mendelian hypotheses are: firstly, that a character which is transmitted by inheritance without splitting up or being diluted or altered is represented in the gametes by one indivisible factor. The gamete either contains this factor or it does not contain it; it must either contain it whole and pure or be entirely free from it. This is the hypothesis of '*gametic purity*.' The characters represented by single factors are called '*unit characters*.'

Secondly, of the gametes produced by a simplex individual, half will normally contain the factor and the other half will not contain it.

Cytology, a science which deals with the structure and development of the innumerable little masses of living matter which built together form the body, has almost brought this assumption into the realms of

observed fact. The significance of many complex processes, described with the aid of the microscope long before the Mendelian theory attracted any attention, was not fully appreciated till viewed in the light which it shed, while the theory itself propounded before such observations were made has been in turn corroborated by them.

Its principles, when once grasped, seem wonderfully simple; but in practical hybridisation many complications arise which can only be unravelled by the use of a considerable amount of ingenuity, coupled with training and experience. How complexity may be introduced into the results may be readily understood by considering what happens when two varieties are crossed which differ not only in one character but in two or more. An example of this may be taken from Mendel's experiments. The ripe dry pea, the seed of the pea plant, in some varieties is yellow in colour and in others green, in some it is smooth and round, and in others it has a shrivelled, wrinkled appearance. These characters of the seed are characters of the embryo plant which it contains. The colour of the two cotyledons or seed leaves, which form the greater part of the embryo, is seen through the more or less transparent seed coat which covers them, and their form, whether round or wrinkled, gives the form to the seed. Yellowness is due to the presence

in the zygote of a factor which is absent in the green pea, and roundness is due to the presence of another factor which is absent in the wrinkled pea.[1] Peas in the condition in which one hopes to find them on the table are all round and green, whatever character they may assume when they are dry. The factor which determines yellowness does so by causing the original green pigment to fade, thus revealing yellow pigment which is also present; and that which enables the pea to keep its original roundness operates by converting the sugar, present in the moist condition of both varieties, into starch. Ths starch, by permanently retaining much more water than the sugar, prevents the wrinkling which is caused by the excessive loss of moisture in drying.

If a round yellow pea is crossed with a green wrinkled one the F_1 generation will be all round and yellow. If R represents the factor for roundness and r its absence, and if Y represents the factor for yellowness and y its absence, the gametic constitution of the peas of this generation can be written Rr, Yy. When they grow into plants they may form gametes of four different kinds, for each may contain either R or r in conjunction with either Y or y. If self-fertilisation takes place, each of these four different

[1] *Vide* Darbishire, *Breeding and the Mendelian Discovery*.

kinds of gametes may unite either with another of the same kind, or with one of the three other kinds, and zygotes built up in sixteen different ways may thus be obtained. They are all equally likely to occur, and they can be represented as follows :—

(1) RY.RY.	(5) R*y*.RY.	(9) *r*Y.RY.	(13) *ry*.RY.
(2) RY.R*y*.	(6) R*y*.R*y*.	(10) *r*Y.R*y*.	(14) *ry*.R*y*.
(3) RY.*r*Y.	(7) R*y*.*r*Y.	(11) *r*Y.*r*Y.	(15) *ry*.*r*Y.
(4) RY.*ry*.	(8) R*y*.*ry*.	(12) *r*Y.*ry*.	(16) *ry*.*ry*.

Although the zygotes are formed in sixteen different ways, there are not in reality sixteen different gametic combinations, but only nine.

If a diagonal line is drawn from the left-hand top corner of the figure to the right-hand bottom corner, it will cut through four combinations which occur each only once, namely—(1) RY RY, (6) R*y* R*y*, (11) *r*Y *r*Y, (16) *ry ry*. On the other hand, all the four combinations which lie on the other diagonal —namely, Nos. (4), (7), (10), and (13)—are in reality the same,* each containing both R and Y and *r* and *y*. There are four other combinations which occur, each twice over—(2) and (5), (3) and (9), (8) and (14), and (12) and (15). But although there would in reality be nine different kinds of zygotes, only four different kinds of pea would be distinguishable by their external (somatic) characters, for the same character is developed

whether the factor is present either singly or doubly in the zygote. All those peas whose zygotes contained R would be round, and all those containing Y yellow. Nine of them—namely, Nos. (1), (2), (3), (4), (5), (7), (9), (10), (13)—contain both R and Y, and would, consequently, be both round and yellow. Three—namely, Nos. (11), (12), (15)—contain Y, but do not contain R, these would be yellow and wrinkled. Three—namely, Nos. (6), (8), and (14)—contain R, but not Y, and would be round and green, while one number (16) contains neither R nor Y, and would be wrinkled and green.

Any one who wishes to understand these deductions from the Mendelian theory is recommended to provide himself (or herself) with an adequate supply of patience, a large sheet of paper and a pencil, and to figure out for himself (or herself) how many different kinds of hybrids could be produced if one were to breed from varieties differing in three, four, five, or more unit characters. In each case, with regard to each factor, he can make the alternative assumptions that the simplex form displays somatic characters similar to that of the duplex, intermediate between duplex and nulliplex, or entirely different to either. The complexity of the results obtained will surprise and possibly confuse him. In actual experimental work further complications are introduced by the

fact that the different factors may exhibit mutual attractions or repulsions, so that two factors controlling the development of different somatic characters may always be, or never be, transmitted in the same gamete.

Up to this point we have spoken as if the somatic character depended on one and only one gametic factor, but many characters which have been shown to be inherited in a Mendelian way depend on the presence or absence of two or more. One of the most interesting and economically important cases of this kind is that of the inheritance of fecundity, or the egg-laying faculty in poultry, which has recently been worked out by Dr Raymond Pearl, of the Maine Experiment Station, U.S.A.

The problem which he has elucidated is a particularly difficult one, and many people have in consequence denied that fecundity is inherited. The denial was reiterated some months after the publication of Dr Pearl's results by the writer of a special article on poultry-raising in the *Times*. Dr Pearl has discovered that the egg-laying capacity of hens depends on the presence or absence of three separate factors in the zygote, which are inherited in a simple Mendelian manner, except that there is repulsion between two of them, so that they are never present together in the same gamete. The egg-laying capacity is judged by the number of eggs laid in

the winter months. Although this depends normally on environmental conditions, the disturbing influence of the latter can be practically eliminated in experiments performed by competent people on a well-equipped farm. The three factors are distinguished by the letters F, L, and L_2. When all three are present in the zygote the highest degree of fecundity is shown, which is found to correspond to a winter production of more than thirty eggs. When F and either L or L_2 are present together, one to thirty eggs are laid. A double dose of L, which may be present, does not produce any greater fecundity than a single dose. L_2 cannot be present twice over, because it is never transmitted in the same gamete as F. When F is present alone, the number is reduced to nothing; but when F is absent, although both L and L_2 may be present and transmitted to the next generation, no eggs are laid, for the fowl is not a hen but a cock.

The statement contained in the last sentence involves a theory which has been seized upon by some 'feminist' writers as a demonstration of the essential superiority of women over men—namely, that femaleness depends on the presence of a factor (referred to as F in the above description) which is absent in the male. The feminist contention need hardly be answered seriously; but the theory itself is one of some importance, and helps

to explain, on Mendelian lines, instances of inheritance which would otherwise be difficult to understand.

If femaleness is determined by the presence of an additional factor, one must suppose that the male is nulliplex, and produces only gametes which do not contain F, and that the female is invariably simplex, producing gametes of which about half contain it and the other half do not. As sexual reproduction necessitates that one gamete must be derived from the male and the other from the female, half the zygotes produced must be simplex and the other half nulliplex, and so about equal numbers of males and females are born.

The theory that sex itself is inherited on Mendelian lines in the manner thus described has been used by Dr Archdall Reid as an argument against attributing too much importance to Mendelism. His view, stated for brevity in a teleological form, is that Mendelian inheritance has been evolved solely for the purpose of keeping the sexes distinct, and preventing the blending of sexual characters, consequently that beyond the primary sexual characters only those which are connected in some way with sex are transmitted in a Mendelian way. Dr Reid's suggestion can hardly be accepted, as it involves a very unnatural straining of the limits of the class of characters associated

with sex; but it is useful in correcting the inference, sometimes rather too readily drawn, that because a large and increasing number of characters are known to be inherited according to Mendel's laws, therefore if the facts were before us it would be found that *all* are. But, although according to the views of the present writer the time for belief in the universal applicability of these laws is a long way off, it may be difficult to disprove that they control any individual case, for if a character depends on the presence in the zygote of a large number of factors, although each may be transmitted strictly in accordance with them, the combined result might be so complicated as to defy analysis.

A case which may perhaps be taken as an instance of this possibility is the blending of human skin colour in inheritance. In crosses between negroes and white men, all intermediate shades between those characteristic of the two races appear to occur, and as a general rule the less negro blood is present the lighter is the colour. At first sight this would appear to be an undoubted example of non-Mendelian inheritance, but, in the light of what has been said above, it would be very unwise to assume this immediately, particularly as it has been found, now that a somewhat closer attention has been given to the facts, that white or negro babies are sometimes born to parents from whom they

would hardly be expected. Mendelism often provides a more charitable and more probable explanation of such phenomena than the suggestion of conjugal infidelity.

At this point those readers who have not already given the chapter up may well ask, What has all this talk about peas and mice and fowls, or even unexpected negro babies, got to do with Eugenics? The answer is that Mendelism is capable of providing in some cases a surer guide to knowledge of probable characters in the offspring of contemplated human matings than any method yet suggested; further, that Mendelism can only be properly investigated by experimental breeding which cannot be performed on human beings. In so far as it applies to human beings it can only be studied by the examination of pedigrees interpreted with the aid of the knowledge derived from experiments.

Several clear cases of Mendelian inheritance in man are now recognised, though the majority of them have little Eugenic significance. One of the clearest is the inheritance of eye-colour, which has been investigated by Major Hurst in England and Dr Davenport in America, to the former of whom the credit of priority belongs. Human eyes, except those of albinos, may be divided into two principal classes, the one containing the blue and gray, and the other the hazel, green,

brown and black and parti-coloured eyes. The anatomical distinction between the two groups is that in the former the pigment apparently colouring the iris is in reality confined to a layer which lies behind it. This layer is seen through the iris and appears clear blue, dullish blue or gray, according as to whether the substance of the iris itself is more or less transparent.

In eyes of the other class there is, in addition, yellow or brown pigment in front, which, varying in quantity and arrangement, gives rise to large range of variety in the colour of eyes which are not either blue or gray.

For simplicity, the two classes will be here referred to as 'blue' and 'brown.'[1] The presence of the front pigment layer in the eye seems to depend on the presence in the zygote of a special factor. Whether this factor is introduced by one gamete or by both the result is the same. Thus persons with 'brown' eyes may be either duplex or simplex. The former produce only gametes containing the factor, and in the latter,

[1] Major Hurst gave them the more correct names of 'simplex' and 'duplex'—the blue having only a single layer of pigment and the brown two layers. The words 'simplex' and 'duplex' were adopted by Dr Davenport, but used by him in an entirely different sense—namely, that in which they have been used in the present chapter. Persons nulliplex (according to Davenport) with regard to eye colour have simplex eyes, according to Hurst; while those who have Hurst's duplex eyes may be duplex or simplex, according to Davenport.

half will contain it and the other half not. The former will only have brown-eyed children, whatever may be the colour of the eyes of their mates. Among the children of the latter, if mated among themselves, a quarter will have 'blue' eyes, and if mated with blue-eyed persons a half. 'Blue'-eyed people are nulliplex, and produce no gametes containing the factor. The children of two 'blue'-eyed parents are thus invariably 'blue'-eyed. The theoretical explanation of these proportions given with reference to the description of the hybridisation experiments on peas and mice applies in exactly the same way here also.

It will, of course, be noted that Mendelism provides a key to a small part only of the facts of inheritance in eye colour. An explanation which involves putting together in one class the large range of varieties, which are here called 'brown,' can hardly be claimed as complete, but one must not underestimate on that account the credit due to Major Hurst for being the first to see something that was before the eyes of all of us, nor the importance of the result in demonstrating that a normal human character may be inherited in a Mendelian way.

The inheritance of eye colour may not appear to have a very direct or immediate bearing on Eugenics, but for the facts just described a parallel may be found in the

inheritance of epilepsy and feeble-mindedness, concerning the practical importance of which there can be no dispute. This will be discussed more fully in a later chapter.

The majority of known instances of the Mendelian transmission in man of characters detrimental to their possessors, are comparatively rare diseases and deformities. A case discussed fully by Professor Bateson[1] is that of Brachydactyly. Brachydactylous persons have very short fingers and toes, which are all two-jointed like thumbs, and not three-jointed like normal fingers and toes. The thumbs are also abnormally short, and so generally are the affected persons themselves. In families in which this condition occurs the males who exhibit it may be as much as 8½ inches shorter on the average than those who do not, and the females 4¾ inches. In these families the descendants of members who are free from the defect are invariably free from it; but when those who show it are mated with unaffected persons, about one-half of their offspring are brachydactylous, and the other half are not. These facts are explicable on the assumption that the abnormality is caused by the presence of a determining factor in the zygote. This is completely absent from normals, who therefore produce only gametes without it. As in the families described abnormals were

[1] Mendel, *Principles of Heredity.* 1909.

always mated with normals all the brachydactylous children born must be simplex. Half their gametes, therefore, would contain the factor, and the other half be free from it. Thus when they in turn were married to normal persons, half their offspring would be simplex, showing brachydactyly, and the other half normal.

It is clear that when facts like this about particular defects are known, their likelihood to occur in the offspring of individual matings may be prophesied with an accuracy which may amount to a practical certainty. In some cases persons born into a family in which a particular defect is present could be guaranteed to be not only entirely free from it in themselves, but to be no more likely to have affected children than any scion of the soundest stock.

The importance of the bearing of Mendelian investigation in Eugenics need not be further insisted on, but we may have long to wait before it becomes a practical guide for the everyday use of persons contemplating matrimony.

SUMMARY OF CHAPTER

To illustrate the principles of Mendelism an account is given of Mendel's experiment of hybridising a tall with a dwarf variety of pea. The first generation of hybrids (F_1)

are all tall, but when they are self-fertilised a quarter of the members of the next generation (F_2) thus produced are dwarfs.

The tall plants can be shown by breeding from them to be of two kinds, one producing on self-fertilisation only plants like themselves, and the other behaving like the plants of the F_1 generation. A quarter of the plants of the F_2 generation belong to the former kind, and one-half to the latter. The explanation given to account for this is that of the two gametes which are brought together to form the zygote in the original cross one contains a factor, which when present in the zygote determines that it shall develop into a tall plant, and the other does not. The members of the F_1 generation containing the factor, though only introduced by one parent, are tall themselves, but produce gametes of which only one-half contain the factor. If self-fertilisation then occurs, or if the flowers are fertilised from plants of a similar nature, each gamete which contains the factor is just as likely to be fertilised by one of the same kind as one of a different kind. Consequently when a large number are fertilised, half will be fertilised by other gametes containing the factor and half by gametes which do not contain it, and the same applies if one considers the gametes which do not contain it. Suppose T to represent gametes containing the factor and *t* those which do

not contain it, then three different kinds of zygotes will be formed. TT, T*t*, and *tt*, and, according to the laws of probability, in every 100 zygotes of the F_2 generation one may expect 25 TT, 50 T*t*, and 25 *tt*. TT and T*t* will be *tall* plants and *tt dwarfs*. TT and *tt* will breed true to the character shown, producing each gametes all of one kind; but T*t* being of the same gametic constitution as the plants of the F_1 generation will behave like them and produce one-half T gametes and one-half *t*.

It is then shown what kind of hybrids will be produced, and in what proportions, if the varieties crossed differ in two unit characters instead of in one; and to illustrate what may occur when a character really depends on the presence of two or more factors, Dr Raymond Pearl's investigations into the fecundity of fowls are considered.

The inheritance of human eye colour is taken as an instance of the transmission of normal human characters according to Mendel's *Laws*, the explanation given being that the presence of an additional factor in the zygote converts blue or gray eyes into hazel or brown, in the same way that a pea plant if it has the right factor present is *tall*; but when the factor is absent, a *dwarf*. Brachydactyly is taken as an instance of a human abnormality, conditioned by the

presence of a determining factor in the zygote, and inherited in the same way. The special importance of Mendelism to Eugenics is then pointed out.

CHAPTER VI

THE STATISTICAL STUDY OF INHERITANCE

WHILE Mendelian investigation, or to speak rather more broadly, the science of Genetics, which has been evolved out of it, is, and promises to remain, the most fertile method of pursuing the study of inheritance, it is not the only one. Though its advance during the last twelve years has been one of surprising rapidity, it has up to the present left many fields unworked, and even if it may be expected to increase a hundredfold the knowledge which we owe to it, there is as yet no indication that its methods of analysis will ever be able to touch some of the problems of inheritance. They may fail for two reasons. First, there may be characters which are not inherited according to Mendel's laws; and, secondly, the somatic character may be determined by so large a number of gametic factors that, although each factor is transmitted unchanged in all its purity, the somatic character might

appear to be completely blended or modified in many other ways by inheritance. It is not in any way in disagreement with Mendel's theory to suppose that a character may depend for its full development on the presence of a hundred factors; but if an individual bearing such a character were crossed with another which did not contain it, the number of hybrids with different gametic constitutions which might arise in the F_2 generation is so vast that their identification would be altogether outside the range of practical Genetics, at any rate at the present day; and it is only by the identification of the different hybrids produced that the number and nature of the factors can be arrived at.

It is in such cases as this that statistical methods may be profitably applied to the study of inheritance. The aims of the statistician in approaching the problem are far less ambitious than those of the Geneticist.[1] The former makes no endeavour to arrive at an understanding of the physiology of heredity—that is to say the workings of its vital mechanism; he tries only to arrive at a simple statement of its effects when observed in a large number of individuals. He attempts to measure the average resemblance shown between parents and children,

[1] Geneticist = a person engaged in the advancement of the science of Genetics.

with regard to the degree of development of the somatic characters studied. This measure is obtained by the calculation of *correlation coefficients*, a method which owes its origin to Sir Francis Galton's study of the inheritance of human stature, but is now applied to many other purposes. Human stature is a character which, probably on account of its dependence on a large number of gametic factors, and possibly owing to its susceptibility to environmental influences, has not hitherto been shown to be transmitted according to Mendel's laws. Thus for historical and practical reasons Galton's study of its inheritance may conveniently be taken as an example of the statistical method.

The material which he[1] used consisted of records of the heights of 928 adults grouped in 205 fraternities, together with the heights of their parents. In order to be able to group men and women together in the same table, it was necessary to transmute the stature of the women in order to make them comparable with those of men. This was done by adding to each observed female stature one inch for every foot of the actual measurement; for example, when a woman's real height was five feet, in order to make it equivalent to a man's height, Galton added five inches, thus converting it into five feet five inches, before entering it in his tables.

[1] *Vide* Galton, *Natural Inheritance.*

Further, in order to take both parents into account, when studying the relation of their stature to that of the children, he did not use the heights of the fathers separately to that of the mothers, but after transmuting the height of the mother he took an average between that and the father's height. This average he called the stature of the *Mid-parent.*

After these preliminaries were completed, a double classification was made: the children were first arranged in fourteen classes, according to stature, and then each class was divided again into groups according to the stature of the mid-parent. The results thus obtained were written in tabular form.[1] (*Vide* Table I.) The table may be read either as a series of vertical columns or of horizontal rows. Each column is headed by a number which signifies the central height in inches of the class of 'children' contained in it. Thus the third column from the left is headed 63·2. As the total range of each class is one inch, this means that all the 'children' in the class lie within half an inch above or half an inch below 63·2 inches.

Corresponding numbers are placed at the left-hand end of each row. Thus the number 72·5 is placed at the end of the second row. This signifies that all the 'children' entered in the row have mid-parents whose

[1] This form of table is called a Correlation Table.

TABLE I.

Heights of the Mid-parents in Inches.	Heights of the Adult Children in Inches. Below 62·2	62·2	63·2	64·2	65·2	66·2	67·2	68·2	69·2	70·2	71·2	72·2	73·2	Above 73·2	Total Number of Adult Children.	Medians.
Above 72·5												1	3		4	
72·5								1	2	1	2	7	2	4	19	72·2
71·5					1	3	4	3	5	10	4	9	2	2	43	69·9
70·5	1		1		1	1	3	12	18	14	7	4	3	3	68	69·5
69·5			1	16	4	17	27	20	33	25	20	11	4	5	183	68·9
68·5	1		7	11	16	25	31	34	48	21	18	4	3		219	68·2
67·5		3	5	14	15	36	38	28	38	19	11	4			211	67·6
66·5		3	3	5	2	17	17	14	13	4					78	67·2
65·5	1		9	5	7	11	11	7	7	5	2	1			66	66·7
64·5	1	1	4	4	1	5	5		2						23	65·8
Below 64·5	1		2	4	1	2	2	1	1						14	
Totals	5	7	32	59	48	117	138	120	167	99	64	41	17	14	928	
Medians			66·3	67·8	67·9	67·7	67·9	68·3	68·5	69·0	69·0	70·0				

stature falls within half an inch of 72·5 inches.

Let us consider the entries of the fifth column in detail. It is headed 65·2 inches, and near its foot may be found the figure 48, which represents the total number of children recorded in the column. By looking down it one may see that one of the 48 falls in the 71·5 inch row, one in the 70·5 inch, four in the 69·5 inch, 16 in the 68·5 inch, and so on. The meaning of the column, therefore, is, that when the whole number (928) of adult children were divided into one-inch classes according to stature, 48 fell within the class centred at 5 ft. 5·2 inches, and that when these were sub-divided according to the stature of the mid-parents, one was found to have a mid-parent in the group centred at 5 ft. 11½ inches, another in the next lowest group, four more in the group centred at 5 ft. 9½ inches, 16 in the group below that, and 15, 2, 7, 1, 1 in the succeeding five subdivisions.

The other columns record corresponding facts about the remaining 880 'children,' which can be easily understood when once the principle on which the table is constructed has been mastered.

The horizontal rows may be read off in exactly the same manner, they only differ from the columns in that the primary classification is according to the height of the

mid-parents, while the secondary classification is based on the stature of the children.

In the lowest row and in the extreme right-hand column of the table are entries of a different character, described as 'medians.' Thus the column headed 63·2 inches has at its foot the number 66·3, and the row which has in its left-hand division the figure 72·5 has at its right the number 72·2. It is on these figures that attention should now be focussed, because they provided the clue which led to the invention of the statistical methods for measuring correlation.

The figure 66·3 at the foot of the column headed 68·2 means that the median[1] stature of the mid-parents whose children fell in the 5 ft. 3·2 inch group column was 5 ft. 6·3 inches; in the fourth column, in which were entered children an inch taller, the median stature of the mid-parent rises to 5 ft. 7·8 inches, and it goes on rising on the whole, though rather unsteadily as the stature of the children rises. It will, however, be noted that the rise in the one case is not so rapid as in the other.

The figure 72·2 at the right-hand end of the second row indicates that the median height of all the children whose mid-parents were in the 6 ft. 0·5 inch group was 6 ft. 0·2 inches. In the next lowest group it was

[1] In considering human stature the median may be taken as equivalent to the average.

5 ft. 9·9, and below that again 5 ft. 9·5, and so on, descending steadily, but not quite regularly to the lowest but one, where it is entered as 65·8 inches, or 5 ft. 5·8 inches. The medians for the outside columns and rows were not calculated because, owing to the small number of the entries in them, they would not give reliable enough results.

It is very difficult to grasp the significance of a table containing many figures, consequently statisticians almost invariably try to represent such tables by appropriate diagrams. Figure 2 is a diagram drawn to represent the essential facts which may be learnt from Table I. In it each column of the table is represented by a vertical line, and each row by a horizontal line; the distance between each vertical line and the lines on either side of it is the same throughout, and may be taken to represent one inch in stature, because the centres of the classes and groups into which the 'children' were divided fell one inch apart. The horizontal lines have the same spacing as the vertical ones. As the vertical and horizontal lines cross one another at right angles, it follows that the former divide each of the latter up into equal parts, thus converting it into a scale of inches, and in the same way the vertical lines are each divided by the horizontal lines into similar scales. This enables one to mark by a dot in the centre of a small

circle on the vertical lines the median height of the mid-parent associated with children of each particular stature. In the same way the middle points of small crosses are used on the horizontal lines to mark the median stature of the children associated with mid-parents of each group. A diagram of a kind essentially similar to this was constructed by Galton, and it enabled him to note that the circles fell roughly on a straight line and so did the crosses; so it occurred to him that the slope of these lines might be used as measure of the degree of interdependence between the statures of the mid-parents and the statures of the children.

If there were no connection whatever between the two, there would be no reason why the height of the mid-parents of all those children who fell in the 5 ft. 4·2 class should be a little higher than that of those in the 5 ft. 3·2 class, and a little lower than that of those in the 5 ft. 5·2 class. Consequently the median mid-parental heights would tend to be the same in each case, and if they were represented as in Figure 2 the little circles would lie clustered about the horizontal line EF, running at the level at which the median height of all the mid-parents taken together might be recorded on the scale. On the other hand, if an increase or decrease of any particular amount in the height of the children was associated with an increase

or decrease of an identical amount in the median stature of the mid-parents, the circles would lie in a line which sloped upwards towards the right hand of the figure at an angle of 45 degrees, which is the angle made with the sides of a square by a line joining two of the corners.

The slope of a line may be expressed in many different ways. For the present purpose it is convenient to use a trigonometrical ratio—namely, the tangent of the angle which it makes with the horizontal. This may be made clearer by reference to Figure 2. Let AB be the straight line which gives the best indication of the way in which the little circles are distributed, and let the horizontal line EF represent the position in which AB would be if there were no connection whatever between stature of the mid-parents and the stature of the children. Let AB cut EF at M. Take any point N on AB, and from it draw a line perpendicular to EF and meeting EF at O. Then the angle NMO is the angle which AB makes with the horizontal, and the length of the line NO, divided by the length of the line MO, is the tangent of the angle NMO. It makes no difference where on AB the point N is taken, for the relation which NO bears to MO is always the same if the angle itself remains the same.

If instead of considering the diagram we consider the facts which it represents, the

last statement may be interpreted as follows:—If a group of children be taken of a stature differing from the average stature of all the children by any definite amount, *x*, large or small, then the average height of their mid-parents will differ from the average height of all the mid-parents taken together by an amount which bears a constant relation to *x*. In Figure 2 the line NO is one-third of the length of the line MO, and this expresses the fact that if one considers a group of children who are all three inches taller than the general average, the average height of their mid-parents will be one inch greater than the general average height of mid-parents, and if the filial deviation be 1 inch or 1½ inches, or any other amount, the associated mid-parental deviation will be one-third of it. This fraction, which, as has been explained, represents the slope of the line AB, Galton called the Mid-parental Regression. He used the word regression to signify that the mid-parents of children who are exceptional in a particular degree are probably also exceptional but to a lesser degree; in fact, they may be said to have regressed or moved backwards towards the average.

Let us now consider the other sloping line on the diagram, CD, which represents most nearly the straight line along which the little crosses tend to lie. Each little cross represents the median height of the children of

the mid-parents belonging to a particular stature group. If the height of the children in no way depended on the height of their mid-parents, the children of any particular group of mid-parents would probably have just the average tallness, neither more nor less. If this state of affairs were represented on the figure, it would be found that the little crosses would lie along the vertical line, GH. The degree of interdependence between the parental and filial statures is thus represented in this case by the angle which the line CD makes with GH. The tangent of this angle is the length of the line SR, divided by the length of the line SM. The fraction thus obtained Galton called the 'Filial Regression'; in the present case it is $\frac{2}{3}$. Interpreting again in terms of the facts represented, we may say that when the mid-parental deviation from the average is any given amount x, the associated filial deviation will be two-thirds of that amount.

The two lines AB and CD are called regression lines. It is now necessary to consider how far the tangents of the angles which they make in the one case with the vertical and in the other with the horizontal form a satisfactory measure of the degree of interdependence, or, as we will say henceforth, of correlation between the filial stature and the mid-parental stature. It seems fairly obvious that the former must be correlated

with the latter to exactly the same extent as the latter is correlated with the former. Yet we find from the figure that the 'Filial Regression' is two-thirds, while the 'Mid-parental Regression' is one-third. Why is there this discrepancy, and how can it be avoided? The reason for it is not far to seek—it lies in the manner of construction of that artificial monster the mid-parent. He is not one person but an average of two, consequently he is far less variable than one person. That this must be so, any one who thinks of the matter for a moment will conclude; but it takes some mathematical reasoning to determine how much less the variability should be. Its results, but not the reasoning itself will be given here; but beforehand, a word or two must be said about the way in which variability may be measured.

Let us suppose that we want to measure the variability in stature of a population, and have for that purpose taken from it at random a sample of a thousand individuals. At first sight it might appear that the simplest thing to do would be to measure the difference in height between the shortest and the tallest, but this would be misleading, because the size of the sample would influence the result. A sample 100,000 strong would probably contain a very much taller man and also a very much shorter man than one of only 1000 individuals. A better way is to

pick out two individuals, one so short that only a quarter of the sample are shorter than he, and the other so tall that only a quarter are taller. These two men may be called the quartiles—half the sample lies between them in stature and the other half outside them. They will differ from one another in stature by a certain number of inches, which is not made larger by increasing the size of the sample or smaller by decreasing it. Half-way between them lies the median, than whom half the sample are taller and half shorter. The two quartiles differ from the median by approximately the same amount, which is called the *quartile deviation*.

Galton used the quartile deviation as a measure of variability, and found that in the general population it is 1·7 inches, half the population differing from the median by less than 1·7 inches, and the other half by more than that amount. If, instead of measuring the variability of individuals, averages are taken of pairs selected at random, and the variability of these averages is measured, then according to mathematical theory their quartile deviation would be that of the separate members of the general population divided by the square root of two. If the quartile deviation in stature of individuals is 1·7, then that of pairs would be, according to this theory, 1·7 divided by $\sqrt{2}$, or 1·21 inches. The quartile deviation

of mid-parents is actually 1·19, a result which agrees very well with the theory.

Since mid-parents are to that extent less variable than their adult children, it would not be incorrect to say that a deviation from the average on their part of any specified amount is equivalent to a deviation on the part of the children of the same amount multiplied by the square root of two. Therefore, if the slope of the regression lines AB and CD in Figure 2 is to be used as a true measure of correlation, the figure should be redrawn with the scale corrected accordingly. Each division on the horizontal scale represents one inch of children's stature, each division on the vertical scale represents one inch of mid-parents' stature. As an inch of mid parents' stature is equivalent to $1 \times \sqrt{2}$ inches ($=1{\cdot}45$ inches) of children's stature, the divisions on the vertical scale should be 1·45 times as long as those on the horizontal scale.

Let us see what the effect of such an alteration would be on the tangents of the angles SRM and NMO.

The tangent of the angle $\mathrm{SRM} = \dfrac{\mathrm{SR}}{\mathrm{SM}} = \frac{2}{3}$.

On the corrected figure SM would be 1·45 ($\sqrt{2}$) times as long, but SR would be the same length. Therefore $\dfrac{\mathrm{SR}}{\mathrm{SM}}$ would be equal

to $\frac{2}{3 \times 1{\cdot}45}$, which, divided out, is equal to ·483. The tangent of the angle NMO $= \frac{NO}{MO}$ $= \frac{1}{3}$. On the corrected figure NO would be increased 1·45 times in length, but MO would remain the same; the value of the tangent would therefore be $\frac{1{\cdot}45}{3}$, or ·483, which is the same as that of the angle SRM.

Thus we see that if the regression diagram is constructed in such a way that the divisions on the two scales which represent inches of stature are proportional in absolute length to the quartile deviations of mid-parents and children, the filial regression line will make the same angle with the vertical that the mid-parental regression does with the horizontal. The tangent of this angle can thus be used as a measure of correlation, and is practically identical with the earliest form of *correlation coefficient.*

If the correlation between the mid-parents' and children's statures were absolutely complete, then a deviation of any given amount in the stature of the one would invariably be associated with an equivalent deviation in the stature of the other, if the word equivalent is taken to mean that the deviation in the one would bear the same relation to the deviation in the other, as is borne by their

respective quartile deviations. Under these circumstances the two regression lines would coincide in position, forming equal angles (of 45 degrees) with the vertical and horizontal. The tangent of the angles would therefore be in each case equal to unity, and the correlation coefficient would consequently be one. If there were no correlation, the one regression line would be horizontal and the other vertical. The lines NO and SR in Figure 2 would thus be reduced to points which have no length, and the tangents of the angles SMR and NMO would consequently be nothing. The correlation coefficient can thus take any value between nothing and unity.

Although it would be possible and theoretically correct to determine its value graphically by drawing a diagram of the kind described above, in practice it is formed directly from numerical tables, like Table I., by arithmetical calculations, which, though they are themselves of an easy and straightforward kind, are based on theories involving advanced mathematics. Coefficients of the kind described above can be calculated to determine the degree of the correlation between any two associated variables which can themselves be measured, as, for instance, the height of man and the length of his legs. Professor Karl Pearson has devised additional methods which can be applied where

no true measurement of the variable characters, but only rough grading or classification, is possible. They all agree in arriving at a number which is equal to unity when the correlation is complete, and to nothing when there is no correlation, and in representing different degrees of correlation by fractions which lie between nothing and unity.

Though all these methods can be, and have been, used for the study of heredity, so far from their scope being limited to this study, it is probable that they may be applied more usefully for other purposes, such as the investigation of many of the problems found elsewhere in Eugenics. It is, therefore, important that the reader should grasp as firmly as possible what the correlation coefficient means.

Galton's statistical investigations into heredity gave rise to many more, which have been carried on almost entirely by Professor Karl Pearson and his pupils. In these subsequent researches it has been found most convenient to keep the two parents and four grandparents separate, and not to combine them into mid-parents and mid-grandparents. Correlation coefficients for a variety of characters have been calculated between fathers and sons, fathers and daughters, mothers and sons, mothers and daughters, grandfathers and grandsons, grandmothers and grandsons, and so on, and also between

brother and brother, cousin and cousin, and other pairs of relations of different degrees. Not only man but many other animals have been studied in this way, and certain general deductions have been drawn from the results.

The correlation between the degree of development of a character in either parent and the degree of development of the same character in the children, either sons or daughters, taken separately, lies often between ·42 and ·52, though higher and lower values have been obtained. As an example of this rule, may be given the following results, obtained by Professor Pearson and Miss A. Lee:—[1]

COEFFICIENTS OF CORRELATION BETWEEN PARENTS AND OFFSPRING.

Character	Father and son	Father and daughter.	Mother and son.	Mother and daughter.
Stature . . .	514	·510	·494	·507
Span (distance between tips of fingers when arms are extended).	·454	·454	·457	·452
Length of forearm .	·421	·422	·406	·421

The correlation between pairs of brother and brother, sister and sister, and brother and sister, is usually a trifle higher than the corresponding relation between parents and children.

The correlation between grandparents and children is often about ·3.

[1] *Biometrika*, Vol. II., p. 278.

The coefficients may be taken as measures of average resemblance between different pairs of relatives, and although they are sometimes referred to as 'coefficients of heredity,' it is incorrect to do so except in cases where it may be supposed that the whole resemblance is in reality due to heredity, and none to the fact that the environmental conditions have been more nearly the same for members of the same family than for members of different families. For such characters as stature, span and length of forearm, if the families investigated came from approximately the same social class, the degree of resemblance due to similar environment cannot be very large, so practically the whole resemblance may be reasonably attributed to heredity.

Under favourable conditions the results obtained by these statistical studies could be made of use to edict the probable offspring from marriages of a particular kind. The mass results to be expected from a large number could by their aid be predicted with considerable accuracy, but in individual cases they could never do more than indicate a probability. The accuracy of the ediction would depend on conditions here to be stated, in a hypothetical concrete case, for which stature can still be conveniently used.

Suppose a man A marries a woman B, what will be the probable adult stature of

any sons they may have? If A's height is known, but B's is not known, some clue to the probable height of the sons would be afforded by the knowledge that the correlation in stature between father and son was ·514; but if B's height were also ascertained, and the correlation between mothers and sons and husbands and wives were known, one could speak with much greater certainty. If records were at hand of the respective statures of A's father and mother and B's father and mother, and the grand-parental coefficients had been calculated, the prophecy could be made much more precise, and the precision would be increased if knowledge of the same kind concerning the remoter ancestry and collaterals was available.[1]

It will be seen from this statement that the character of the ancestry, as well as the character of the parents, influences the nature of the offspring; a tall man's sons are likely to be taller if his father and mother are also tall, and taller still if the peculiarity was present in his grandparents.

How does this agree with the following fact mentioned in the description of Major Hurst's discoveries about the inheritance of eye colour in man? Two blue-eyed people have all blue-eyed children, no matter how

[1] Professor Karl Pearson's theory of multiple correlation enables one to combine individual results in this manner.

many among their parents or grandparents had brown eyes; so in this case the eye colour of the ancestry appears to be without any influence on that of the children.

Speaking more generally, it may be said to follow from the Mendelian theory that when the gametic constitution of the parents are known, a knowledge of their ancestry will not give any additional clue to the probable nature of the children. Many writers have seen in this apparent conflict between the statistical and Mendelian point of view evidence of an irreconcilable difference between them. There is, however, no necessary antagonism here. In the cases such as that of stature, a knowledge of the stature of the parents gives no indication of their gametic constitution, and the additional information concerning the grandparents and other relatives is useful just because it gives some sort of clue to it. In cases of obvious Mendelian inheritance where the gametic constitution is known, the ancestry may safely be neglected; but it is often the characters of the ancestors which provide part of the data for determining what the gametic constitution actually is.

We have up to this point been attempting to show how by the calculation of correlation coefficients it is possible to obtain some sort of measure of the intensity of inheritance, which may be useful as guide to the probable

results of particular matings. We now propose to give an instance of the use of statistical methods of a simpler kind for answering the easier question whether heredity does or does not take a share in the causation of some particular qualities or defects. The instance is one of interest, because it deals with a subject which has a direct and immediate bearing on Eugenics. It is taken from a memoir by Dr J. A. Murray, in the fourth scientific Report of the Imperial Cancer Research Fund, published in 1911. It is now generally accepted that cancer itself is not inherited, but that in many forms of the disease it is initiated by a 'long continued process of localised chronic irritation.' The question, however, remains whether the tendency for the part or organ irritated to respond by the development of cancer is or is not an inherited one. It is a question of exceptional difficulty to investigate in human beings; but if it can be answered for in another mammal, some useful preliminary knowledge will have been gained. Dr Murray therefore started investigations on mice, which are particularly suitable, as they are short-lived animals, easily bred, and very liable to be attacked by cancer. The nature of his material limited him to one particular form of the disease,—namely, cancer of the mamma, which corresponds to cancer of the breast in human beings.

All the mice which he had under observation came from strains in which cancer was known to have appeared at one time or another, so the question he set himself to answer was, whether mice whose mothers or grandmothers had been thus affected were more liable to develop the disease themselves than those in whose remote ancestry only it had occurred. The mice were all kept under standard conditions, so that no disturbing effect was to be feared from the environment; but in mice, as in human beings, the liability to be attacked with cancer varies considerably from age to age, and accordingly in making a comparison between the two classes it was necessary to group each according to age, and to compare them group by group.

Let us call the class of mice which had mothers or grandmothers with cancer A, and the other class whose mothers and grandmothers were free from it B. There were found to be 340 female mice in the A class and 223 in the B class. Among the A class there were sixty-two who had lived to be nine months old, and in the B class thirty-eight. Among the former 6·5 per cent. had died of cancer of the mamma, among the latter 2·6 per cent. Sixty-three of the A's had lived to be twelve months old, and in 11·1 per cent. death had been caused in this way, while among the forty-one B's who had lived to this age 9·8 per cent. had suffered.

24·2 per cent. of the fifteen-month old A's had died of cancer, but only 3·8 per cent. among the twenty-six B's of this group; and if one traces them through the other classes, the A's, or those who had cancer in their immediate ancestry, invariably showed a higher percentage than the B's. The following table supplies the actual figures :—

Class A.	Age in Months.						
	9	12	15	18	21	24	over 24
Total number in each group . .	62	63	62	56	40	29	28
Percentage who died of cancer of the mamma	6·5	11·1	24·2	32·1	25·0	17·2	10·7

Class B.							
Total number in each group . .	38	41	26	38	29	26	25
Percentage who died of cancer of the mamma .	2·6	9·8	3·8	21·6	0·0	11·5	8·0

On the face of it, the comparison shows that inheritance plays some part in the causation of mammary cancer in mice; but the number compared in each group is rather a small one, and it is not easy by the light of nature to say how much reliance may be

placed on the calculated percentages. In deciding this point, Dr Murray follows the best practice of statisticians, and applies the mathematical theory of probabilities to determine whether the differences shown in the percentage of cancerous mice in each age-group really indicate that the disease is more likely to occur in the A class than in the B, or whether they are a chance result due to the numbers being too small to decide the point. Tested by the theory of probabilities, it was shown that if each age-group were considered separately it was exceedingly improbable that the differences shown in the fifteen, eighteen, and twenty-one-month groups were due to chance, but to the remainder no significance could be attached. If, however, all the groups are considered together, the fact that the differences are all in the same direction very greatly strengthens the conclusion that the A class, with recent cancerous ancestry, is in reality the more liable to the disease; a fact which can be most readily accounted for by the supposition that the liability to cancer is in this case at any rate inherited.

Dr Murray regards this only as a provisional conclusion, and perhaps it will be said that even if the fact were finally established it would be unsafe to argue from it that the tendency to cancer is inherited in human beings. In answer, we would point

out, in the first place, that the investigation has only been described here as an instance of the application of simple statistical methods in a legitimate way for the study of an important problem; and, secondly, that in the absence of positive evidence to the contrary it would be safer to assume that the tendency to cancer is inherited in man, than to assume that this is not the case.

SUMMARY OF CHAPTER

Statistical methods are useful for the study of inheritance, at any rate in cases which elude Mendelian analysis, either owing to their too great complexity or because they are exceptions to Mendel's laws.

The systematic statistical study of inheritance was initiated by Sir Francis Galton, who invented for this purpose the 'Regression Diagram,' and expressed the degree of resemblance between parents and children, and between members of the same fraternity by regression coefficients, which were calculated graphically by drawing lines and measuring their steepness. The regression coefficients had certain disadvantages which are absent in the correlation coefficients. The earliest form of correlation coefficient is essentially the regression coefficient modified by drawing the regression diagram in such a way that the quartile deviation (or other measure of

variability) of one of the two associated variables is represented on the vertical scale of the diagram by a line equal in length to that which represents the quartile deviation of the other variable on the horizontal scale. It is, however, usually arrived at by an arithmetical and not by a graphical process. The great development of the theory of correlation is due to Professor Karl Pearson, who has invented methods by which the degree of interdependence between the variables may be measured, even if the variables themselves cannot be directly measured, but can only be divided into grades or classes.

The sort of generalisations concerning heredity which may be arrived at by the calculation of correlation coefficients are then described and their possible use in predicting probabilities. The chapter concludes with a description of a statistical research into the inheritance of the tendency to develop cancer among mice, as an example of the kind of results which can sometimes be obtained by the use of quite simple methods.

CHAPTER VII

THE INHERITANCE OF ABILITY

In his *Memories of My Life*, Galton writes that in the year 1860, or thereabouts, 'most authors agreed that all bodily and some mental qualities were inherited by brutes, but they refused to believe the same of man.' Man's physical qualities might be inherited, but his mental qualities were not. But owing to Galton's own investigations, and those of other writers, a mass of data was accumulated which seemed to show that this view was a wrong one, and that mental character followed the same rule as physical. Thus gradually psychic inheritance was accepted as a firmly established fact, and replaced in fiction other and vaguer forms of the ever-popular 'Hand of Destiny.'

It is doubtful whether its reality would now be doubted, if it were not that it seems to conflict with many cherished beliefs and many educational theories. Yet whatever the reasons may be, there appears at the present day so strong a tendency to question it, that it is worth while to pass in review the evidence in its favour, in order to show, if possible, that it is worthy of credence. If physical characters only were inherited

there would still be some reason for Eugenics, but its scope is vastly extended by including with them the propensities and peculiarities of the mind.

A complete account of the evidence is of course impossible in a work of this kind, for its full consideration might occupy a large volume. It is, however, possible to give some indication of its nature, and although no claim will be made that a rigid proof of the inheritance of mental faculties has been established, it is hoped that as good a case will be made out as many on which a man has been hanged.

As few will dispute that mental diseases, deformities, or deficiencies are or may be inherited, their consideration will be reserved for another chapter; in this place 'ability' will be the principal subject discussed.

Ability depends partly on certain inborn qualities of mind and partly on education. Psychologists distinguish between mental capacity and mental contents. The latter consist of memories, faculties, and habits which, with the aid of the former, have been implanted in the mind by education and experience. It is not supposed that mental contents are inherited, so the student of heredity is concerned directly only with mental capacity; but he is met at once by the difficulty that in the majority of cases there is no measure of mental capacity but

mental contents. And the difficulty does not end here, for in most of the data available he has often no satisfactory way of estimating mental contents, but must rely on records of achievements which depend, at any rate, partly on opportunity. Psychologists are now devising means for arriving at a direct measure of mental capacity, and one may eventually look to their efforts for providing material for the study of its inheritance; but as up to the present little has been achieved in this direction, we have to fall back on older and less precise methods.

An example of results obtained by these is Galton's *Hereditary Genius*; here he endeavours to prove that 'genius' is hereditary by showing 'how large is the number of instances in which men who are more or less illustrious have eminent kinsfolk.' Writing in 1865, he does not use the word genius in the sense in which it is commonly used now, and he explains in the prefatory chapter of the edition of 1892 that if the title could then be altered he would alter it to *Hereditary Ability*; at the same time, he is careful to explain that the word ability does not truly represent his meaning, as it does not exclude the effects of education.

Galton uses the words eminent and illustrious in perfectly definite senses. The former term is applied to people who have achieved a position about equivalent to

that attained by one person in 4000. The word illustrious is only applied to the few who reach the far higher level attained by only one in a million. He proceeds to argue that reputation which leads to distinction is a true test of natural ability, provided that reputation is taken to mean 'the opinion of contemporaries revised by posterity,' and that natural ability is 'those qualities of intellect and disposition which urge and qualify a man to perform acts that lead to reputation'—for instance, capacity, zeal, and the power of doing a great deal of very laborious work. The opportunities for rising are so numerous that a man provided with these gifts is almost certain to rise to a position in which they will be recognised. 'Social hindrances cannot impede men of high ability from becoming eminent.' 'Social advantages are incompetent to give that status to men of moderate ability.'

After giving many reasons to support these views, Galton goes on to examine the relatives of groups of men eminent in different walks of life. The English judges between the years 1660 and 1865, who are described in Foss's *Lives of the Judges*, are taken as the first group. They number 286, and of these 109 have one or more eminent relatives, and upwards of seventy, two or more.

If only one person in 4000 reaches the degree of distinction classed by Galton as

'eminence,' it is obvious from these figures that the relative of a judge has many times a greater chance to become eminent than any person chosen at random from other sections of the community. But Galton does not rely for his demonstration of heredity on arguments such as these, but goes on to inquire to what extent the nearness of relationship gives an additional chance of attaining this degree of success. Taking the families in which several eminent men were found, he groups the various members according to their degree of kinship to the most gifted member, and then finds the percentage of eminent men in each group. Among the descendants 36 per cent. of the sons were eminent, 9 per cent. of the grandsons, and 1½ per cent. of the great-grandsons; among the ascendants, 26 per cent. of the fathers, 7½ per cent. of the grandfathers, and ½ per cent. of the great-grandfathers. Among collaterals there is a similar falling off as one moves farther away from the central figure.

In addition to this it was found that among the more distinguished of the judges the percentage of those who had eminent relatives was more than twice as high as among the less distinguished. In the families of twenty-four out of thirty, or 80 per cent, of the Lord Chancellors eminence was reached by other members, while in the families of the remaining 256 judges this occurred in only 90 cases, or

36 per cent. To meet the obvious objection that Lord Chancellors have more opportunity than others of thrusting their relatives into eminence by jobbery, Galton goes in detail into the families of the twenty-four Lord Chancellors, and finds that there is little doubt of the real ability of the eminent men among them.

These conclusions were supported by those arrived at upon applying the same methods of consideration to the families of men pre-eminent in other walks of life.

The problem is attacked in a slightly different manner in a more recent work,[1] in which an attempt is made to estimate how many members of the families of the Fellows of the Royal Society attained in their own occupations an amount of distinction about equivalent to that sufficient to qualify a scientist for the fellowship. Accounts are given of those families in which three or more of the members had at least this amount of success, and a cursory glance through them should be enough to convince any one that the accumulations of such men in particular families can hardly be attributed to chance.

One may, of course, be willing to concede this, and yet deny that heredity is the effective cause. A particularly favourable environment common to the members might be sufficient to bring about the same result.

[1] Galton and Schuster, *Noteworthy Families.*

We will return to this point after considering further evidence.

In order to meet the objection that family patronage is sufficient in itself to be taken as the reason of the kind of facts recorded above, Dr Woods[1] collected data of something the same kind in America, where, he argued, owing to different social conditions, family influence is not so powerful and the opportunities for distinction are much less unequally distributed than in the older countries. On the banks of the Hudson, in New York, is an arcade which contains memorials to those who have been the most illustrious members of the American Republic. Only forty-seven people have up till now been admitted to this Temple of Fame, the qualifications for admission to which are extremely high. In our country the claims of candidates for the highest posthumous honours are decided on in a hurry by persons selected for quite a different purpose, and upon qualifications only slightly connected with their ability to form a sound opinion on this particularly difficult question. Thus it might happen that the merely temporary wave of popular appreciation, on which public men are sometimes raised during their lifetimes, is sufficient to carry them up to the highest

[1] Dr F. A. Woods, *Some Interrelations between Eugenics and Historical Research*. Read before the First International Eugenic Congress, 1912.

honours with which the nation can express its gratitude to the great men who have died. In order to avoid this danger, no one is allowed to enter the American Hall of Fame until several years after his death, and then only with the approval of a committee of a hundred of the most distinguished men of the day.

Dr Woods set on foot an investigation into the family histories of these forty-seven in order to find how many were related as closely, or more closely, than grandfather to grandson, to members of another group of 3500 men whose distinction was of a considerably lower degree, but high enough to warrant their inclusion in one or other of two standard biographical dictionaries. Fully one-half of the forty-seven had close relatives among the 3500, and for the whole forty-seven, the average was more than one apiece. Now the chances of any man, taken at random, having so close a relative in this larger group is about one in 500 to one in 1000. So Dr Woods concludes: 'The amount of distinguished relationship which the Hall of Fame gives is about a thousand times the random expectation.' He goes on to say, 'Intellectual distinction is just as much of a family affair in the new country and in a freer atmosphere as it is on this[1] side of the Atlantic, where the social lines are supposed to be more strictly drawn.'

[1] He was speaking in London.

We will next describe some statistical results of a rather different kind obtained by an analysis of the Oxford examination records.[1] The arrangements of the final examinations, qualifying for the degree of Bachelor of Arts at the University of Oxford, are such that it is possible to divide the men who have gone through the University into six classes with respect to their success. They may pass these examinations with honours of four different grades—first class, second class, third class, and fourth class; they may pass without honours; or they may fail to pass at all. It is thus possible to form a sort of scale of success with first-class honours at the top and failure to obtain a degree at the bottom, and the six divisions of the scale will form a rough measure of the kind of ability which enables people to succeed in examinations. It is not claimed that men divided according to this scale will be really accurately sorted, for many good men are prevented by accidental circumstances from taking degrees, and some who are capable of obtaining fairly high honours may be led by a variety of motives to attempt nothing more ambitious than a pass.

Whether the honours examinations really test the kind of ability that is useful in after life is an open question, but it may safely be

[1] *The Inheritance of Ability.* By Edgar Schuster and E. M. Elderton.

asserted that they form a fairly accurate measure of one particular kind of talent, for a man's tutor is able to gauge the class to which he will attain with so much accuracy, that it is evident that whatever may be the conditions most favourable to success, it can rarely be merely due to a happy chance. It is not our purpose to analyse the special talents which lead to success in examinations, but it may safely be asserted that they are formed from mental qualities which are present to a most marked degree in first-class honours men, to a slightly less degree in second-class men, and so on down the scale. Pass men have it developed on the average less than those placed in the fourth class, and more than those who do not obtain degrees. It must be remembered in reviewing the results that what inaccuracies this method of measurement introduces will tend to weaken rather than strengthen the apparent amount of resemblance shown between members of the same family, except where they are introduced by the action of family custom or tradition, when they will be likely to have the opposite effect.

The system of honours was introduced into the University in the year 1800, and records were available of the degree taken by each man who entered from that year to 1892, and of the degrees taken by their fathers and brothers, if these had

also been at the University during this period.

There were about 4000 men between the years mentioned, whose fathers had also been up, and had had the opportunity of entering for honours. These were first divided into two groups, according to the date at which they took or failed to take their degrees. 2459 were placed in the most recent group, and were found to consist of 149 men with first-class honours, 329 who were placed in the second class, 377 in the third, and 190 in the fourth. 868 had taken a pass degree, and 546 had taken no degree at all. Each of these six classes was subdivided according to the nature of the degree taken by the father, and a table was constructed on much the same principle as Table I., Chapter VI. It is unnecessary to go into the details of the table here, some of the essential facts which could be deduced from it are shown in Figure III., in which the percentage of fathers who took either first or second class honours is shown, by the length of a vertical line, for each of the six groups of sons. The steady way in which this percentage sinks as one passes down from the highest group to the lowest is the feature to which it is desired to call attention. The same phenomenon recurs among the earlier group of sons in a manner almost more decisively marked.

Measured by the correlation coefficient, the

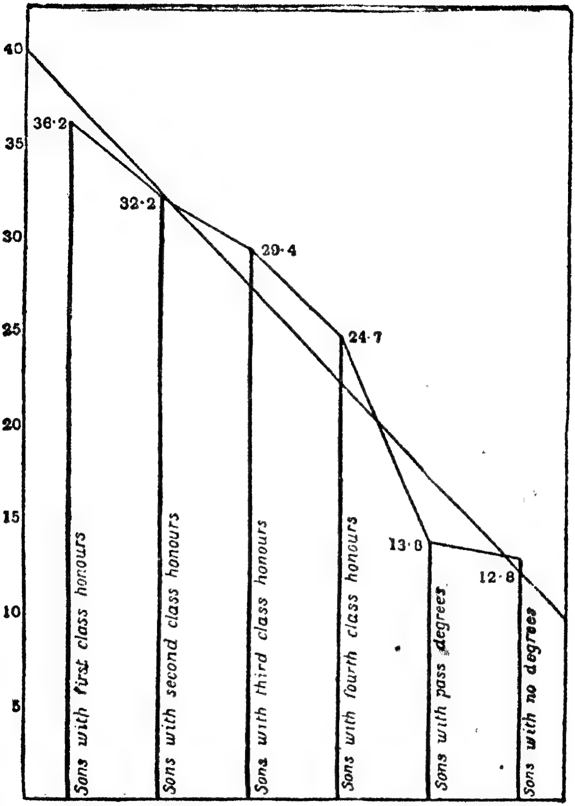

FIGURE III. (date of degree of sons, 1860-92).
The heights of the vertical lines show in what percentage of cases the fathers have taken either first-class or second-class honours. The diagram is intended to show that the percentage of fathers who obtained this degree of distinction diminishes with some regularity, as one passes downwards from the sons with first-class honours to those with no degrees.

From Schuster and Elderton, *Inheritance of Ability* (Eugenics Laboratory, Memoirs I.).

significance of which is described in the last chapter, the resemblance between fathers and sons with regard to the degree taken can be represented as about ·3, or almost one-third. The result is not very different whether the earlier or the later group is dealt with.

The resemblance between brother and brother was measured in an almost identical way. The material was divided in this case into three groups, according to the period in which the degrees were taken, but closely accordant results were obtained in each case. The coefficient of resemblance never differed widely from ·4. The school lists of two public schools—namely, Harrow and Charterhouse—were subjected to an analysis of a very similar kind, which, in so far as it went, provided corroborative results. It was not possible on the basis of this material to draw any comparison between fathers and sons, but the resemblance between brothers was shown to be about as close as was indicated by the consideration of the Oxford Examination lists.

The resemblance between children of the same parents with regard to some physical and intellectual characters was the subject of an important research conducted by Professor Karl Pearson, with the assistance of many collaborators. His 'Huxley Lecture,'[1] delivered before the Anthropological Institute, contains a description of the results

[1] *Biometrika.* 1904.

of this investigation. The material on which it was based was collected by the masters and mistresses in a very large number of different schools. The mental or physical characters investigated were Vivacity, Assertiveness, Introspection, Popularity, Conscientiousness, Temper, Ability, Hand-writing.

As no means has yet been discovered for obtaining a direct mechanical measure of any of these qualities, the estimates of the school masters and mistresses had to be relied on. From these estimates the boys and girls could be divided for each character into two classes. Take as an example 'ability.' In the directions which were sent out as to how the blank schedules should be filled in, instructions were given to assign to each child one of the following six grades of intelligence:—Quick Intelligent, Intelligent, Slow Intelligent, Slow, Slow Dull, Very Dull. But in constructing the tables the first two grades were united to form one class and the lower four grades the other. From one table it was then found that when the two classes into which the six original grades were grouped are called respectively Intelligent and Dull, 666 pairs of sisters were both intelligent and 655 were both dull, and in the remaining 792 cases one was intelligent and the other dull.

From figures such as these correlation coefficients can be calculated with perfect

facility. Each of the eight psychical characters was treated in this way, and for each the correlation between brother and brother, sister and sister, and brother and sister were worked out. Thus twenty-four coefficients were obtained, of which none was lower than ·42, and none higher than ·62. The majority clustered round ·52.

These values are probably higher than would be the case if an accurate impersonal measure of the degree of the development of the characters invesitgated had been made. There is, however, no means available for making such a measure, and we must therefore be content with estimates such as were used. They would probably not introduce any serious error, if it could be assured that the same standard was applied by each teacher; but, as in marking examination papers some examiners are apt to give slightly higher marks than others, so it is probable that one teacher would enter boys or girls as intelligent, whom another would regard as slow intelligent, or a third as quick intelligent. As both members of the same pair would often be judged by the same teacher, the result would be that out of a group of children who all really belonged to the intelligent class some pairs of brothers or sisters would be entered in the quick intelligent and others in the slow intelligent class. *Mutatis mutandis* the same would be true

about the higher and lower divisions of the intelligence scale and about the other psychical characters. This would give rise to an apparent correlation between children of the same parents, even if there were no real resemblance between them.

It would be unfair to say this without also explaining that where the two members of a pair were not judged by the same teachers, differences in the standards employed might give rise to apparent diversity in cases where there was real similarity, and simple faults of judgment would tend to have the same effect. Thus errors in the values of the correlation coefficients introduced in the manner first described would be counterbalanced to some extent, though probably not entirely, by those last described, which have a different influence on the results.

Up to this point we have endeavoured to show by the consideration of evidence drawn from various sources that members of the same family tend to resemble one another with regard to their mental characters, and that this resemblance can be roughly measured. We have not tried to prove that it is due in any degree to heredity.

If mental characters were wholly due to the environment, resemblances between persons closely related to one another would also be shown, since it is probably true that members of the same family are subjected to more

nearly similar environmental influences than members of different families. While admitting that part of the resemblance may be accounted for in this way, we intend to argue that certain facts are absolutely inconsistent with the supposition that the whole may be, and that if to some extent psychical characters are not determined by the environment, then to that extent the most credible theory to account for them is that mental capacity is inherited.

This argument has been put forward in a forcible manner by Dr Woods, as a result of his studies on heredity, as shown in the pedigrees of royal personages, and his words will here be quoted :—

'When complete pedigrees can be constructed and information obtained concerning the lives, achievements, and characteristics of whole family groups, the wicked as well as the virtuous, the stupid as well as the brilliant, it becomes evident at once, on examining such charts, that the strongest contrasts are everywhere the rule, even among those close of kin. *A similar environment ought, if effective, to mould people towards the same mental pattern.* But royalty, historically considered, has not been so moulded. There is no reasonable cause why Frederick the Great was so different from his weak-kneed and almost forgotten ancestor, George William of Brandeburg, except inborn determiners.'

It is unnecessary to raise one's imagination to these extreme social altitudes to reach a similar conclusion. Most people with fairly developed powers of observation, who have had reasonable opportunities for mixing with their fellows, should be able to some extent to examine the question in the light of their own personal experience. Familiarity with the characteristics of several members of half a dozen families will generally reveal differences between brothers which cannot be accounted for by pointing to any differences in the conditions under which they were brought up.

The fact that sharp contrasts in character and ability between near relatives do undoubtedly exist is quite incompatible with the view that mental qualities are determined wholly by the environment, but is consistent with theories of heredity, which, like the Mendelian, recognise alternative inheritance or the circumstance that characters latent through many generations may reappear clearly and definitely when the right combination of gametes or germplasm is formed.

The conclusion that mental capacity is to some extent inherited seems to follow almost as a necessity from this train of argument. But we will not leave it without examining other facts, which may directly corroborate it. For these we will turn first to the comparatively new science of Experimental

Psychology. The general aim of this science is to describe and analyse mental processes by devising experiments to test quite simple faculties. Its primary object is to find out the way in which the mind works, but its methods of investigation can be applied profitably to the study of inheritance. It deals with characters which are much simpler and much less dependent on education or environment than any which can be estimated by success in life or success in examinations. Frequently a positive measure of some kind can be applied which does not depend on the idiosyncrasies of the person who applies it, thus the chances of error referred to in describing Pearson's work on the inheritance of psychical characters may be entirely eliminated.

The contributions which experimental psychology has made up to the present to the study of inheritance are very small, but such as they are they seem a step in the right direction.

As an example may be taken some of the work of Mr Cyril Burt,[1] who compared three groups of children of the same age, the first from a preparatory school at Oxford, the second from a higher elementary school at Oxford, and the third from Liverpool slums. The first group were for the most

[1] 'Experimental Tests of Higher Mental Processes and their relation to General Intelligence,' *Journal of Experimental Pedagogy*, 1911. 'The Inheritance of Mental Characters,' *Eugenics Review*, July, 1912.

part the sons of university professors, college lecturers and tutors, Fellows of the Royal Society, and bishops—all men whose position in life depended to a great extent on their intellectual attainments. The second group were principally the sons of small tradesmen.

The tests applied were very various in their nature; some of them were thought by the boys to be like drawing-room games. For instance, one of the most reliable, 'The Alphabet Test, consists in measuring with a stop-clock the number of seconds required to pick out, in order, one complete alphabet from two alphabets of cardboard letters, arranged in irregular array upon a prepared sheet.' In another the boys were required to erase the letters O and E from a page of capital letters printed in haphazard order. The number of letters correctly erased in two minutes was taken as the measure of success.

A third was a missing-word test: 'A piece of prose is given with certain words omitted, and the boys had to supply in the places left the words that best completed the meaning suggested by the context.'

In another the boys were given a sheet of paper, on which 100 words were printed in columns; they were required to write opposite to each the first word suggested by it. Thus after black such words as ink or white could

be written. The number of words supplied in 7½ minutes was here used as the measure. In addition to the tests here described, many others were employed, and the results correlated with the teachers' estimates of the boys' intelligence. It was found that, for some of them the correlation was fairly high, for others less high, or absent, or even negative.

In these tests, which were highly correlated with general intelligence, the Oxford preparatory school boys did uniformly better than the Oxford elementary school boys, while the latter were considerably in advance of the boys from the Liverpool slums. In the alphabet test, for instance, the average time taken by the first-named group was 74 seconds, by the second 91 seconds, and by the last 123 seconds.

It would be difficult to explain these results on any other theory than that mental capacity is inherited. Whatever are the innate differences between university professors, small tradesmen, and the denizens of the Liverpool slums, by the time they reach adult life there is little question that the order in which they would be placed with regard to their intellectual qualities is the same as that in which they are here written, and it can hardly be maintained that the sons of the first group have much better opportunities for acquiring the faculties which enable them to come well out of

the alphabet test than those of the second group.

Mr Burt[1] has also been able to obtain some more direct evidence by measuring the correlation between adults and their parents for various relatively simple psychical characters. For the degree of sensitiveness of the skin, measured by the æsthesiometer, the coefficient of correlation was found to be ·29. For 'Reaction Time' (*i.e.* the interval that elapses between the exhibition or application of a stimulus to an individual and his response to it in a prescribed manner) the coefficients of correlation were found to be ·33, where the stimulus was some object suddenly displayed, and ·27 when the signal was given by sound.

In addition to this, Professor Thorndike,[2] of Columbia University, investigated the resemblance between twins, using tests of a somewhat similar nature to those employed by Mr Burt (marking particular letters in printed sheets of letters arranged at random, or words in an unknown foreign language; marking misspelt words in a passage of easily worded prose; adding and multiplying simple sums; supplying words meaning the opposite of those in a printed list supplied). The degree of similarity between the twins of a pair was found to be very high. The

[1] From an account very kindly given to the author by Mr Burt of some researches still in progress.

[2] Thorndike, *Educational Psychology*.

correlation coefficients between them for the various characters measured were never lower than ·69, and went up to ·90. Professor Thorndike is careful to point out that twins are probably under the influence of a very similar environment, to which some of the resemblance may be due; but argues that if the environment is its principal cause, the resemblance ought to increase as the children grow older and the environment has more and more time to act on them. Instead of this being the case, he found on dividing them into two groups, one aged 9–11 and the other 12–14, that the resemblance is actually closer in the former group than in the latter. The correlation between children of the same parents a few years apart in age for some of the same characters was found to be considerably less than that between twins.

Both Mr Burt's results and those of Professor Thorndike are based on numbers which are rather small to deduce any but provisional conclusions from, and there are additional objections to the work of the latter; yet when all allowances are made, there remains evidence of some importance when taken in conjunction with that previously cited, while the methods which they have indicated ought in the future to prove a fruitful source of more accurate knowledge of the subject.

A study of the differences in the mental powers of different races is another field to

which one might turn for evidence of inheritance. If it were found that the inter-racial differences are considerable and could not be accounted for by differences in the conditions of life, it would be fair to conclude that inheritance played a part in their causation.

Unfortunately there appears to be no subject on which accurate data are less easily obtained than this, and it would be unsafe to base any argument for inheritance on the slender material at present available. The general conclusion to be drawn from it is that uncivilised races, with one or two exceptions, are not markedly different with regard to some mental characters from societies which have been in a high state of culture for many centuries. From this, one inference may perhaps be drawn which supports the basic principles of selective Eugenics—namely, that centuries, even millennia, of culture have not succeeded in affecting any marked improvement in man's mental nature, therefore the mental development which is one of the objects and results of education does not appear to be inherited.

The directed evidence bearing on the inheritance of mental capacity has now been sufficiently discussed, but there are certain *a priori* arguments bearing on the question which deserve a passing mention.

It may well be, and has been, claimed that the distinction between mental and physical

characters is more apparent than real. Mental characters may be regarded, to some extent at any rate, as the outward expression of such undoubted physical characters as the structure of certain parts of the brain. There are many facts recorded to suggest such a view. For obvious reasons it is difficult to prove that brain structure is inherited, but it would be surprising if it were an exception to the rule which applies to every other part of the body, and some direct observations have been made which seem to show that this is not the case. The brains of two or three members of a certain number of families have been removed after death and their external features compared, and it has been found definitely that as to the manner in which the surface is infolded there is more resemblance between members of the same family than between members of different families. Though this external configuration may not be a character on which mental capacity depends to any very large extent, the fact of its hereditary transmission undoubtedly tends to show that the brain is merely a part of the body subject to the same laws as other parts, and therefore that if special or general ability depends to some extent on its structure to that extent it too will be inherited.

After considering the published evidence a word must be said of facts which most people

may collect for themselves. They are difficult to record, but are perhaps more convincing than any quantity of statistics. If one knows well several members of a family, one is bound to see in them likenesses with regard to mental traits, both large and small, which may sometimes be accounted for by example on the one hand or unconscious imitation on the other, but are often quite inexplicable on any other theory than heredity. It is difficult to understand how the inheritance of mental capacity can be denied by those whose eyes are open and whose minds are open too.

SUMMARY OF CHAPTER

This chapter provides a brief survey of the evidence on which the case for the inheritance of mental characters such as ability rests. Resemblance in achievement and reputation between members of the same family is shown by Galton's work on *Hereditary Genius*, part of which is here described, and by other work of a similar nature. It is argued that such similarity in reputation depends largely on similarity in the ability, without which the reputations would not have been made, even if family influence provided exceptional opportunities for it. Dr Woods's researches on the relatives of Americans whose distinction has been recognised by placing them in the Temple of Fame

show that in a country where family patronage is much less powerful than here there is the same degree of family resemblance.

The statistical statement of the likeness shown by sons to their fathers with regard to success in examinations for the degree of Bachelor of Arts in Oxford is then cited, together with Professor Karl Pearson's measure of the resemblance with regard to psychical characters between brothers and sisters while at school.

The question then arises whether this resemblance is really due to heredity or to similarity of environment, and it is shown by considering the sharp contrasts between members of the same family brought up in the same environment that the latter cannot be the only or even the more important factor.

The results obtained by the methods of Experimental Psychology are then examined, and appear to support this conclusion. Finally, another line of reasoning is suggested—namely, that as mental capacity is largely the expression of physical characters, and as it may be supposed that all physical characters are inherited, it follows that mental capacity is probably inherited also.

CHAPTER VIII

TUBERCULOSIS, INSANITY, FEEBLE-MINDEDNESS, AND EPILEPSY

Of the many diseases in the causation of which heredity has been regarded as an important factor, there is none more common or more deadly than tuberculosis. No one disputes the fact that pulmonary phthisis or consumption, the form of tuberculosis that most frequently causes death, has a strong tendency to run in families, and up till the last part of the nineteenth century the medical profession attributed this to inheritance. When the tubercle bacillus was discovered, it became obvious that the disease itself was not inherited, and in consequence the opinions of physicians swung over to the opposite extreme, and now many, if not the majority, declare that infection is the only cause, that heredity plays no part whatever, and that consumption runs in families because if one member catches it the others get infected. The latter view has been widely accepted, because belief in it makes the prospect of entirely preventing the disease appear more hopeful, and the human mind is always ready to believe what it wants to believe. Indeed, while Charity is but moderately active, Faith and Hope seem to have run mad. It has even been asserted that it is useless to

build Sanatoria durable enough to last more than ten years, because in ten years' time the Insurance Act will have abolished consumption.

It is possible to take up an intermediate position between the old opinion and the new. One cannot maintain that there can be tuberculosis without infection, but various considerations may still be urged to support the view that different individuals have the power to resist it in different degrees, and that in consumptive families a lack of resisting power is transmitted from parents to children.

That the tubercle bacillus is everywhere about us, and that comparatively few people entirely escape its attacks are facts now generally admitted. But the disease may occur in so slight a form that the person attacked recovers from it without being aware that anything has been wrong. Is it something in the man or something in the microbe that causes such differences in the severity of the disease? Professor Metchnikoff[1] says that it is something in the microbe. His theory is that there are some deadly and virulent strains of tubercle bacilli and others comparatively inoffensive, and that if one has the good fortune to be attacked in one's youth by the latter, one acquires the same kind of immunity against the former as vaccination gives one against smallpox. This may be true; it does not exclude the possibility that

[1] *Bedrock*, January, 1913.

there is something innate in the man, planted there by inheritance, which is the cause of the effects described.

Social conditions provide data for determining the relative shares of heredity and infection in the production of consumptive families which are almost as easy to interpret as the results of a simple experiment. If it is argued that parents live with their children, and are therefore likely, if tubercular, to impart the disease to them, it must also be admitted that husbands live in as intimate association with their wives and are just as likely to infect them or to be infected by them. The environmental conditions, such as housing and ventilation, are the same in each case, and can therefore be disregarded; so that if heredity is a negligible factor, the correlation between husband and wife with regard to the presence or absence of consumption should be as high as that between parents and children. This is very far from being the case. Whereas the correlation between parents and children for pulmonary tuberculosis lies between ·4 and ·6,[1] that between husband and wife lies between 0 and ·8[2,3]. Even in the latter case not all of this

[1] Karl Pearson, *A First Study of the Statistics of Pulmonary Tuberculosis.* 1907.

[2] Ernest Pope, Karl Pearson, and E. M. Elderton, *A Second Study of the Statistics of Pulmonary Tuberculosis: Marital Infection.* 1908.

[3] Charles Goring, *On the Inheritance of the Diathesis of Phthisis and Insanity.* 1909.

can be attributed to marital infection, as it may be partly due to assortative mating or the well-known tendency of like stocks to intermarry. This tendency, the influence of which varies from one class to another, is clearly shown in characters, in the causation of which infection plays no part. Thus the marital correlation for insanity among upper class families was found to be ·3 (Pearson, Elderton), among the well-to-do and prosperous poor ·35 (Goring). Among the very poor and destitute it is nil (Goring); but in this class the correlation between husband and wife for consumption is also at its lowest. For physical characters generally, such as stature, the correlation between husband and wife in the well-to-do classes varies about the average value of ·24. Further, in the same classes and districts positive correlation was found between the presence of tuberculosis in the wife's family and in the husband's. It thus is quite clear that some allowance must be made for assortative mating, and when this has been made there is but little left to be attributed to infection. On the other hand, there is, as has been previously stated, a strong correlation between parents and children who have no greater opportunities for affecting one another. So the conclusion seems to follow inevitably that the correlation must be largely due to the inheritance of the tuberculous diathesis—that is to say, the

special liability to be infected with a serious form of the disease.

Other arguments confirm this conclusion. Tuberculosis and certain types of insanity are often associated together. According to Dr Mott, the pathologist to the London County Asylums, 'the death-rate from pulmonary tuberculosis for the insane between the ages of fifteen and thirty-five is about fifteen times that of the sane for the same age period.' This difference cannot be attributed to infection, because among the 1800 attendants in the asylums tuberculosis has been very rare, and if infection were the principal cause the disease would certainly be common among the attendants also. Nor can it be attributed to insanitary conditions such as bad air or bad food, because in these respects a high standard is maintained, and indeed the asylums are far healthier as places of residence than the homes from which the patients come. The only cause which can be assigned to it is some inborn defect of physical vitality which renders lunatics of this description an easy prey to the ubiquitous tubercle bacillus in the same way as their minds through some inborn defect are unbalanced by the shocks and stresses commonly met with in life, and by events or habits which have little effect on persons of ordinary mental stability.

That heredity plays an important part in the propagation of insanity itself is disputed

by few. It is easy to adduce facts to support it. For example, Dr Mott points out that among 20,000 patients in the London County Asylums, 725, or 3·6 per cent., have either a brother or sister, a parent or a child in the asylums. He argues that it cannot be supposed that if 20,000 people were picked at random from the classes which supply the asylum population so many would be so closely related: and therefore heredity must play a part in making the selection.

Dr Heron,[1] making more precise calculations from data which, though not very extensive, had been very carefully collected, estimates the correlation between parents and children to be between ·45 and ·55, which is approximately the same as that for physical characters such as stature.

The examination of detailed pedigrees in addition to statistical considerations of insane stocks leaves little room for doubt concerning the inheritance of insanity. Yet it is as inaccurate to talk of the inheritance of insanity as the inheritance of tuberculosis. The immediate cause of the latter is the attack of a microbe, and of the former it may be one of the many incidents or accidents in the life of the insane person; but in the same way as those who are free from the tuberculous diathesis can repulse the attack

[1] *A First Study of the Statistics of Insanity and the Inheritance of the Insane Diathesis.*

without knowing that it has taken place, so those who are free from the insane diathesis can pass with mind unshaken and unconscious of any danger through all the crises of life, whether brought on by outside events or by the changes that occur in the body at certain special epochs. It should be noted that to speak of the definite presence or absence of the insane diathesis is incorrect, for the mental instability which is denoted by this term occurs in varying degrees. In some cases the mind is fairly stable, and then it takes much to unbalance it; in others a less severe strain is needed; while in others again it gives way at the first test.

Of the crises which arise naturally in the normal life of the individual, puberty comes first in order, and takes its toll of the mentally unstable. The women who pass safely through this period are severely tested by child-bearing, and many fail. For both men and women, the climacteric, or the close of sexual life, is a time of danger, through which all who live to reach it must pass. Among abnormal conditions which have a disturbing influence, mental stress, whether sudden or prolonged, is one of the most important; it affects women more than men. Intemperance in alcohol, which is in many cases considered the principal factor in an attack of insanity, appears to send many more men than women into the asylums. The same is true of

injuries and accidents. The particular symptoms by which the insanity manifests itself appear to depend partly on its cause, partly on the age at which it occurs, and partly on the predisposition of the individual. That the last statement is true is indicated by the fact that particular forms of insanity appear to run in families.

From the point of view of Eugenics, the most dangerous form is recurrent insanity. Patients suffering from it have sometimes had as many as twenty attacks; they have been admitted twenty times and more into the asylums, and each time, after a few months, discharged as 'cured.' In their sane intervals some of them have had many children. There is one case on record in which such a man has begotten six more of the same kind.

General paralysis of the insane affords an exception to much of what has been said above. It is now recognised as a possible sequel to a particular contagious disease, and it occurs in no other way. There is no evidence that hereditary predisposition plays any part in its causation.

The prevalence of insanity throughout the country is a matter of very serious import, and the fact that it has been increasing at a relatively higher rate than the population has given rise to much alarm in many quarters. But while the matter should not be put aside with careless optimism, there

are some reasons for the belief that much of the increase is apparent rather than real. These reasons which have been clearly stated by Dr Mott,[1] may be summarised as follows:— In the first place, the standard of sanity has been raised. In London particularly the special schools for the feeble-minded serve as a collecting agency, and more or less harmless idiots who would formerly have lived at large are now confined in asylums. Further, the accommodation for lunatics has been doubled in the county of London during the last twelve years, and, in consequence, patients, who before that would have been discharged as cured to make room for urgent cases, are kept for longer in the asylums.

Secondly, improved sanitation has had a marked influence in the death-rate in asylums. Where formerly large numbers of cases died young of tuberculosis and dysentery and pneumonia, a much smaller number do so now, and many of those who escape live to a fair age as chronic incurable cases.

Thirdly, a number of aged people suffering from senile decay, who used in former years to live in workhouse infirmaries, are now certified as lunatics and sent to the asylums. The fact that the Government pays the guardians 4s. per week for each pauper

[1] F. W. Mott, F.R.S., *Heredity and Eugenics in Relation to Insanity*. Read before the Eugenics Congress, 1912.

lunatic is an inducement to them to send them.

Mental deficiency, or Amentia, is distinguished from other forms of mental disease or deformity in being commonly congenital. It is defined by Dr Tredgold[1] as being 'that state in which the mind has failed to reach normal development.' As this definition raises the difficult question as to what is normal development, he gives as an amended form the following—Amentia is 'a state of mental defect from birth, or from an early age, due to incomplete cerebral development, in consequence of which the person affected is unable to perform his duties as a member of society in the position of life to which he was born.'

Three degrees of Amentia are distinguished: Idiocy, Imbecility, and Feeble-mindedness. Idiots are persons 'so deeply defective in mind from birth, or from an early age, that they are unable to guard themselves against common physical dangers.' Imbeciles can do this, but cannot earn their living, while the feeble-minded can, under favourable circumstances, become self-supporting, but cannot 'compete on equal terms with their normal fellows, or manage themselves or their affairs with ordinary prudence.'

Tredgold estimates the number of mentally defective persons in England and Wales to

[1] A. F. Tredgold, *Mental Deficiency (Amentia)*. 1908.

be about four per thousand of the whole community. Of these about ten per cent. are idiots, thirty per cent. imbeciles, and sixty per cent. feeble-minded. Both on account of their far greater numbers, and because they are free to conduct their own affairs in whatever manner pleases them, though unable to do so 'with ordinary prudence,' the feeble-minded constitute a greater danger to the community than do the idiots or imbeciles. These, by reason of their greater incapacity, are for the most part under confinement or some control which prevents them from inflicting damage on themselves or others, or from propagating their like.

From the feeble-minded the majority of the inmates of Inebriate Reformatories and a large proportion of the migratory population of prisons and 'Rescue Homes' are drawn. Educated at great expense to the community, while still young they are turned adrift into the world, and their instincts and appetites, which are often perverted and never less strong than those of normal people, lead them into temptations against which their mental equipment of judgment or self-control is wholly inadequate to guard them. Their natural defects are not such as to render them distasteful as mates either to one another or to many of those who are technically normal, neither are they usually

deficient in fertility; so through legitimate and illegitimate unions they add their quota to the ranks of those who are a blessing neither to themselves nor others.

Owing to the fact that amentia is by definition a defect which is either congenital or arises very early in life, the influence of heredity as a factor in its causation is hardly open to question. That environmental conditions may sometimes be responsible is the extreme length to which those can go who would emphasise the importance of external factors, while preserving some regard for the truth. The environmental conditions must necessarily be those which operate either before, during, or immediately after birth. Among these, parental alcoholism is regarded by many as the most important. This has been thought to act either on the germplasm before conception, or directly on the unborn child during its prenatal life. *A priori* considerations might well lead one to believe that alcohol circulating in the mother's blood and transfusing thence into the vessels of the child might well modify in a harmful manner the rapid process of growth and tissue differentiation which it is undergoing, with the result that normal development of mind and body is prevented. It is also not incredible that a somewhat similar result might be obtained by the action of the alcohol in the germplasm itself. But direct

evidence of a convincing kind as to the exact effects of either of these supposed methods of action seems to be extremely difficult to obtain; although much sought, it has not yet been found.

Of the other external conditions, injuries to the brain before, during, or after birth are probably in a small percentage of cases the cause of amentia. Tredgold says concerning such cases: 'It is probable that rupture of vessels has taken place, leading to the destruction of a localised area of brain tissue, and in most of these patients the amentia is accompanied by epilepsy or paralysis.' Among the other factors, he attaches most weight to the action of acute infectious diseases occurring in infancy.

But direct inheritance undoubtedly plays a far greater part in the production of feeble-mindedness than the sum total of contributing and alternative causes. Recent work carried out under the auspices of the American Eugenics Record Office[1] suggests that a Mendelian interpretation can be put upon the facts; indeed Dr Davenport and Dr Weeks appear to do so without doubt or hesitation.

The basic hypothesis of these authors is, that for normal mental develpoment it is

[1] C. B. Davenport and D. F. Weeks, *A First Study on Inheritance in Epilepsy.* D. F. Weeks, *The Inheritance of Epilepsy,* read before the Eugenics Congress, 1912.

necessary that a particular determining factor should be present in the zygote. The factor is transmitted in a Mendelian way, and where it is absent epilepsy or feeble-mindedness appear. The simplex[1] individuals (whose zygotes contained the factor singly) may either appear normal or have an intermediate mental status, which renders them sometimes alcoholic, sometimes neurotic, and sometimes in some other way abnormal without being actually epileptic or feeble-minded. To be thoroughly normal one must be duplex and have the factor present twice over. If this hypothesis is correct,[2] the children produced by two feeble-minded parents, or by two epileptic parents, or when one is feeble-minded and the other epileptic, should all be tainted with one or other of these two defects. Where one is normal (duplex) and the other feeble-minded, the offspring should all be simplex and possess the 'intermediate status,' or appear normal. When both are simplex, one-quarter should be truly normal, one-quarter epileptic or feeble-minded, and the other half simplex. Simplex mated with normal should give one-half normal children and the other half simplex, and simplex mated with epileptic or feeble-minded should give one-half simplex and the other half epileptic or feeble-minded. When

[1] For the Mendelian Theory, *vide* Chapter V.

[2] It has recently been much modified by Dr. Davenport.

both parents are normal (duplex) their children should all resemble them in this respect.

The material analysed by Dr Weeks and Dr Davenport consisted of the pedigrees of inhabitants of the New Jersey State Village for Epileptics at Skillman. Their collection was an arduous and valuable piece of work, performed by Mrs Woodward and Miss Devitt of the Eugenics Record Office. The actual results obtained agree only just well enough with the expectation deduced from the suggested hypothesis to render the latter provisionally tenable. It is to be hoped that future work may confirm and extend it. Extension is necessary because the theory is incomplete—even if it should be eventually accepted without reserve—both as a true explanation of the facts and as a reliable guide for the prediction of the offspring to be expected from marriages in which one or more epileptics or feeble-minded persons are concerned. Its defect is that the two conditions which are very different in their symptoms, and may occur separately or in conjunction, are put into one class, and no account is taken of the degrees of severity in which each may be present.

The difference between the theoretical expectation and the actual facts found consists principally in an excess of feeble-minded or epileptic children recorded in the pedigrees.

Dr Weeks endeavours to bring hypothesis and fact into better agreement by tentatively attributing this excess to parental alcoholism.

The results of this research emphasises the importance of preventing, in whatever manner may be practicable without being harsh or unjust, the reproduction of epileptics and feeble-minded persons. Among the feeble-minded more than in any other class the tendency for like to mate with like must be a strong one, and where this occurs there seems little reason to suppose that healthy or normal offspring can be expected. Even where one mate is a normal the offspring are not completely so, so that when they in their turn form unions with others of their own class, three-quarters of their children may be to some extent defective. Such unions are not so unlikely to occur that their probable results can be looked on with equanimity.

A fact of great importance, and one which tends to simplify the practical problems confronting the Eugenist, is that the harmful predispositions or inborn deficiencies discussed in this chapter are apparently not independent one from another. A family in which one in common is less likely to be free from the others, and its members are often in other ways degenerate, being either addicted to alcohol, unable to earn a living, or prone to become vagabonds, prostitutes,

or criminals. Thus by placing the feeble-minded under care of a kind which prevents them propagating, one would not only do something to exterminate feeble-mindedness, but one would at the same time be dealing a blow at tuberculosis, drunkenness, pauperism, prostitution, and criminality.

There are many other defects, such as deaf-mutism and some forms of eye disease, which are hereditary in their nature, and place a serious handicap on those who suffer from them. In regard to all, the part played in their causation by the marriages of near kin has for many years aroused discussion. Public opinion has been generally set against marriages of first cousins, but little evidence has been recorded to support it. If the two cousins who marry are entirely free from latent defects, there does not seem to be any ground for supposing that their children are more likely to be defective than those of people unconnected by close kinship. But it is almost impossible to say definitely that no latent defect is present. Where the same abnormality exists in the germplasm of both partners, it is more likely that their children will be affected, than if the defect present on the one side is different to that on the other. The latent characters of cousins are much more likely to be similar than those of two unrelated persons, so it follows that, on the whole, it is safer for cousins not to inter-

marry. This conclusion can be more strongly insisted on when the presence of some particular latent defect is suspected.

SUMMARY OF CHAPTER

It is generally admitted that tuberculosis tends to run in particular families. This was formerly attributed entirely to heredity, but now many people say that it is due entirely to infection. There is some evidence that it is due to the infection of persons who have been provided through inheritance with a very low power of resistance against the attacks of the microbes which cause the disease. Parents are as likely to infect one another as to infect their children, yet the correlation between parents and children is undoubtedly much higher than between husband and wife. The inheritance of the tubercular diathesis is the most reasonable explanation of the difference.

Insanity is also caused partly by the external conditions and partly by the natural tendency, and in this case there is little doubt that the tendency is inherited.

In the causation of mental deficiency or amentia, the environment acting directly on the individual probably plays a smaller part than in tuberculosis or insanity, because amentia is congenital, or is set up very soon after birth. Its hereditary nature is therefore more obvious, and the work of

Dr Davenport and Dr Weeks shows that feeble-mindedness and epilepsy may perhaps be inherited in a Mendelian way.

Some of the problems in Eugenics are simplified by reason of the fact that all these defects and some others tend to occur in the same stocks.

Lastly, the view now generally accepted as to the dangers of marriages between cousins is discussed.

CHAPTER IX

THE INFLUENCE OF THE ENVIRONMENT

EVERY part of any human body, whether it be an organ present in all mankind or the peculiarity of one or a few individuals, every habit of body or mind, every form of skill, every faculty and every disease is guided in its develpoment directly or indirectly by the nature of the germplasm and by the external conditions through which the individual is passing or has passed. If some characters, such as the colour of the eyes, appear to be wholly unaffected by the environment, it is because the external conditions which permit their development are so varied as to include almost all those in which life itself is possible. If others, such as a scar on the cheek, appear to depend wholly on external influence, it is because they are represented

potentially in every zygote, but actually develop only under certain well-marked conditions.

The joint action of nature and nurture is obvious in most cases, and in many it is difficult to say to which should be attributed the preponderant influence. Galton's classical study of the resemblances and differences exhibited by twins was an attempt to find a general solution of this problem. By assiduous correspondence he collected much information concerning a hundred pairs of twins, and he found that they fell naturally into two discontinuous[1] groups according to the degree of likeness between the members of a pair. In the one, each twin resembled its fellow very closely from infancy upwards in a great many ways, and the two were always of the same sex. In the second the sex was sometimes the same and sometimes different, and there were often remarkable contrasts in body and mind. The twins of both groups were naturally exposed as they grew up and went out into the world to conditions which, from being almost identical, became more and more different. Of those who showed so great a resemblance in early childhood some diverged to a certain extent from one another, but

[1] Groups are called discontinuous when they do not shade by insensible gradations into one another, but are quite distinct.

others maintained a close similarity throughout life—a similarity which often extended from personal appearance to mental characteristics and to the liability to various diseases. Galton sums this up as follows:—'We have seen that a few twins retain their close resemblance through life; in other words, instances do exist of an apparently thorough similarity of nature, in which such difference of external circumstances as may be consistent with the ordinary conditions of the same social rank and country do not create dissimilarity. Positive evidence such as this cannot be outweighed by any amount of negative evidence.' Even the divergence which occurred in some cases is not necessarily entirely the result of external conditions; it may be due to some extent to innate differences manifesting themselves late in life.

If the action of the environment were very powerful, it should be clearly shown in the case of the dissimilar twins, by their becoming more and more alike, when exposed during childhood to almost identical conditions. That this was far from happening is shown by the collected evidence, of which the following is a sample:—'One parent says: "They have had exactly the same nurture from their birth up to the present time; they are both perfectly healthy and strong, yet they are otherwise as dissimilar as two boys could be, physically, mentally, and in their emotional

nature." According to another parent, the twins are "Very dissimilar in body and mind: the one is quiet, retiring, and slow but sure; good-tempered, but disposed to be sulky when provoked;—the other is quick, vivacious, forward, acquiring easily and forgetting soon; quick-tempered and choleric, but quickly forgiving and forgetting. They have been educated together and never separated." '

There is much more to the same effect, but this is sufficient to support the argument,[1] which may be briefly recapitulated as follows:—The twins who were similar in childhood remained in many cases very much alike in after life, although exposed to different conditions. Those who were different to start with remained different, although subject in childhood to almost identical conditions. Therefore nurture failed in the one case to make different people who were similar by nature, and in the other to make similar people who were by nature different. It follows that nurture is sometimes at any rate less powerful than nature.

It is profitable to turn from a rather general treatment of the question such as is given above to detailed studies of particular points.

Of these, two of the most important have

[1] The argument will be recognised as that used by Dr Woods many years later in discussing heredity in royal personages. It is quoted in Chapter VII. of this volume.

been made respectively by Professor Karl Pearson, with Miss Barrington, and by Dr David Heron. They are both published among the memoirs of the Galton Eugenics Laboratory. Professor Pearson and Miss Barrington deal with the inheritance of vision and the relative influence of heredity and environment in sight. Their work consists essentially of two parts. In the first, statistical measures of resemblance between parents and children, and between children of the same parents, are obtained for various of the commoner defects of vision. In the second, the correlation between the home environment of school children and the state of their eyesight is estimated.

Basing the first part of their work largely on records made by the Swiss oculist, Dr Adolf Steiger, they found a high degree of correlation between parents and children, with regard to the degree of development of corneal astigmatism and refractive errors. When dealing with pairs of brothers or sisters, well-marked similarity in the condition of the eyesight was found also, and the results obtained from Steiger's material were corroborated by much which came from quite other sources. The actual value of the correlation coefficients which express the degrees of similarity referred to above are not given here. The subject is one of so much difficulty that the whole process of reasoning

by which the final values are obtained is too elaborate to be conveniently summarised. It is enough to say that there is ample justification for the conclusion that the 'physical characters of the eye are hereditary qualities,' and some basis for the further assertion 'that the intensity of inheritance is probably exactly the same as that for other physical characteristics in man.'

The study of pedigrees confirms the general conclusion that the condition of the eyes is apt to be inherited, and shows that the inheritance of some of the rarer defects is Mendelian in its nature.

Professor Pearson and Miss Barrington used for the second part of their work the *Report on the physical condition of fourteen hundred school children in the city* (of Edinburgh), *with some account of their homes and surroundings*, published by the Edinburgh Charity Organisation Society. The home environment of these children was classified—first, according to the number of people per room; secondly, according to the economic conditions, judged by particulars as to wages earned and such other facts as would enable one to form an opinion as to how poor they were; thirdly, as to whether the parents were in good physical condition or bad; and fourthly, according to the moral condition of the parents, judged by such particulars as were available.

The eyesight of the children was classified according to its keenness, or to what refractive faults, if any, were present. But whatever classification was adopted, either of the homes or of the children, it was never found that defective sight was associated more with a bad environment than with a good.[1]

In this case at any rate, then, 'Nature' plays a larger part than 'Nurture,' as represented by such home conditions as were investigated. The authors of the memoir further discuss the theory that school is the principal cause of near sight or myopia. This theory rests largely on certain statistics of the German oculist Cohn, which show that the degree of myopia among school children increases with the length of time for which they are at school. Working with Cohn's data, Professor Pearson and Miss Barrington found that the coefficient of correlation between this defect and the length of school life was ·244. This might at first sight appear to be a demonstration of the theory; but, they argue, it is well known that, quite apart from school life, children grow more short-sighted as they grow up, and it must be the case that the children who have been longest

[1] It is possible that a good home environment and a bad, each in different ways, have a harmful effect on the eyesight. In the former, the children would be likely to stay indoors more and read, or otherwise employ their eyes on close work; in the latter, by poor nutrition, bad air, and so on.

at school will generally be the older ones. Therefore the increase in the defect apparently due to school life is due really to increasing age. To test this, using the same data, they calculated the coefficient correlation between degree of myopia and age, and found it to be ·331, thus showing that it is age which plays the predominant part.

Dr Heron's work on the *Influence of Defective Physique and Unfavourable Home Environment on the Intelligence of School Children* is based on a survey of the children in fourteen L.C.C. schools, which was set on foot by Dr Kerr, the medical officer of the Education Committee.

The children were divided by the teachers in each of the schools into five different categories of Mental Capacity. One of the chief difficulties in the work was caused by the manner in which this grading was done. In one school a third of the number of the boys and girls were classed as brilliant, and in another a thirtieth. It is obvious that in the former the word must have been used in a sense very different to that in which one is accustomed to use it, and, what is more to the point, very different from that in which it was used in the latter. In order to get over the difficulty thus introduced, it was necessary to do the statistical calculations for each school separately. The other characters which were measured or estimated in one way or

another and correlated with intelligence were weight and height, condition of clothing and teeth, state of nutrition, cleanliness, and the condition of the cervical glands, tonsils, and adenoids, and the power of hearing. But from the results obtained it could not be shown that mental capacity depended to any appreciable extent on any of the other characters dealt with. The character most closely associated with intelligence was the state of the clothing in girls. The brighter girls were undoubtedly better dressed than the rest; but, taking the other facts into consideration, it is more reasonable to suppose that their comparatively tidy and well-kept costumes were due to their greater cleverness than that both were the result of their coming from better homes. In boys, mental superiority exhibited itself more markedly in personal cleanliness than in the state of their garments. But the relation was not such a close one as between clothing and intelligence in girls.

It cannot be claimed that the researches which have been briefly described go far to settle the general question as to the relative influence of nature and nurture. That is a problem for which no general solution can be found. They do not even go far towards answering the more particular questions as to how far the state of the eyesight and the intelligence of children depend on the conditions under which they are brought up.

Conditions not dealt with in the memoirs quoted may have a far greater influence than those which have been investigated; but even if this is the case, the authors cannot be blamed for it, as the limitations of their material hemmed them in at all points. On the other hand, the great merit is theirs of leading the way in the application of exact statistical methods to these difficult problems, as well as of obtaining results which are themselves of some considerable value as far as they go. The relatively quick and certain method of direct experiment is not available for the study of mankind, so the investigator must rely either on statistics or on arguments from analogy. By statistics rightly applied he may cut his way through the thick jungle of confusing details, overshadowed and obscured by ignorance and prejudice, and, moving laboriously step by step, at last map out the features of the unknown land. But quick progress under these conditions must not be expected from him, and some false starts are almost inevitable.

There are one or two fields in which there is some general experience of the effects of nurture, and these must be examined before leaving the subject. It is well known that by developing a group of muscles with special exercises they grow stronger and larger, but they do not go on increasing indefinitely;

after a time a point is reached at which all that exercise can do is to keep them in condition. Similarly with regard to skill of some particular kind, like that required for playing golf; a point is reached at which further improvement seems impossible, even with the best of tuition and all the practice that is good for one. After a time even the best professional comes to a standstill; his drives do not become straighter or longer, or his mashie shots more accurate. With race-horses a corresponding limit is reached; training appears to make an enormous difference up to a certain point, but beyond that point is powerless to increase their speed. A parallel case is found in the candidates for an examination leading to some valuable prize—for instance, the Civil Service. They may not all be crammed to quite the same degree, but many of them have been trained to the limit; yet the marks show the most enormous differences between the first few candidates. Similarly among race-horses, some descend to the cab rank, while others may earn an annual income about double that of a cabinet minister. Professional golfers are constantly competing one against the other, both in the open championship and in other competitions, yet one or two may head the list again and again; and finally, among those who practise the cult of the dumb-bell to an equal extent some acquire the muscular development of

a Sandow, while others retain the proportions of ordinary mortals.

All these cases show that nurture has some power to mould the individual, but that nature says the last word. They all exaggerate the apparent effect of nurture in the following way. When one sees the feats performed by the highly trained man or beast, one is apt to compare them with the achievements of the untrained and attribute the difference to training, yet training is only given to the naturally apt, so the difference must be largely due in reality to the natural aptitude.

From a consideration of racial stature limits, the same sort of conclusions may be drawn. There is hardly a doubt that stature is influenced by good and bad conditions; but the average stature of races living under conditions not markedly different may be very great.

The point need not be laboured further. Galton illumines the question of 'nature and nurture' with the following parable, which contains a large measure of truth:—'Many a person has amused himself with throwing bits of stick into a tiny brook and watching their progress; how they are arrested, first by one chance obstacle then by another; and again, how their onward course is facilitated by a combination of circumstances. He might ascribe much importance to each of these events and think how largely the

destiny of the stick has been governed by a series of trifling accidents. Nevertheless, all the sticks succeed in passing down the current, and in the long run they travel at nearly the same rate. So it is with life in respect to the several accidents which seem to have a great effect on our careers. The one element which varies in different individuals, but is constant in each of them, is the natural tendency; it corresponds to the current in the stream, and invariably asserts itself.'

If it is difficult to tell how much influence on the individual may be exercised by the environment acting on him directly during his lifetime, it is much harder to estimate what may have been its action previous to his birth. The latter is a problem with three main divisions, each quite distinct from the others. In considering what these are, one must bear clearly in mind the distinction drawn between the soma or body and the germplasm which lives, as it were like a guest, within the body. It will be remembered that each individual (*vide* Chapter V.) is formed from a zygote made up by a portion of the germplasm contained in each parent, and that early in the development of the zygote a certain part of the germplasm is set aside unchanged with regard to its essential nature; from this the gametes are formed from which the next generation springs, while the rest controls the growth and

differentiation of the various parts of the body or soma.

Now the first question is: Can any changes produced in the soma of a parent by accident, by the special exercise of any particular organ, or through any of the other channels through which the environment may act on the individual, so influence the germplasm from which the offspring of that particular parent will be partly derived, that the same changes will reappear in it? In other words, are mutilations, the effects of disease or of use or disuse, of climate or nutrition, and so on, inherited?

The second question is: Can the environment act on the germplasm directly or through the medium of the parental soma so as to change it in such a way that the soma of the offspring develops in a different manner to that in which it otherwise would? The difference between the two questions can be illustrated by reference to a special case. Suppose a man, in consequence of habitual drunkenness, to develop cirrhosis of the liver, and afterwards to have children. If the first question could be answered in the affirmative, his children would have a good chance of developing cirrhosis of the liver without drinking at all. If, on the other hand, it must be answered in the negative, then they would be no more likely to suffer from the disease than if their father had been a

teetotaller. If the second question is stated in the terms of this special case, it would run more or less as follows:—Can the alcohol circulating in the father's veins and thus penetrating to all parts of the body poison the germplasm in such a manner that when the paternal gamete fertilises the maternal the zygote is not able to develop quite normally, and some defect of mind or body in the offspring results?

The third question deals with the influences acting on the individual in his prenatal life. To what extent will his chances in life be affected by the acts, habits, and circumstances of his mother during her pregnancy?

The first question may be dismissed very briefly. The bulk of scientific opinion is so opposed to the idea that modifications produced in the parental soma by the action of the environment can be inherited, and the evidence in favour collected up to the present is so slight and so much open to criticism that a negative answer may be given with as much certainty as can be attained in questions of this kind.

Such a definite opinion cannot be expressed with regard to the action of the environment on the germplasm. Some of the more strenuous temperance reformers have collected data from which they deduce arguments to show that the germplasm may be poisoned by alcohol, in such a way that the children of

intemperate parents are more likely to be feeble-minded or lacking in bodily vigour than they would have been if the parents had been more moderate. Others go even further, and assert that even moderate and abstemious consumers of alcoholic beverages exercise by these habits a deleterious influence on their children. What they say may be true or it may not; but when the reasoning on which the assertions are made is subjected to a critical examination[1] so many fallacies can be detected in it, that no weight whatever can be attached to the conclusions. The cause of temperance rests on so firm a basis that it cannot be permanently damaged by any form of mis-statement; but if one thing rather than another tends to weaken it, it is the emphatic but unproved assertion of some of its more zealous supporters, that parental alcoholism, through its action on the germplasm, is the direct cause of feeble-mindedness, insanity, and degeneration of various kinds in the offspring. The general question, if not the specific influence of alcohol, can be more profitably studied by experiments on the lower animals. By well-devised experiments it is always easier to

[1] Such a critical examination is made in Professor Pearson and Miss Elderton's *Second Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring*. Eugenics Laboratory Memoirs XIII. The reader interested in the question is referred to this memoir, which, he will see, is impossible to analyse satisfactorily in this volume.

obtain a definite answer more quickly than by the observation of very complicated phenomena. And though a completely open mind may be as rare among scientists as among politicians or social reformers, yet the affairs of mice and beetles are less apt to be misinterpreted through prejudice or Jesuitically misrepresented than those of the human species.

Of the results obtained experimentally, those of Professor Tower on a small beetle, called *Leptinotarsa*, are definite enough to be worth quoting. He first was careful to find out by inbreeding and cross-breeding that he was dealing with a stable species, which normally produced its like and had not latent in it any particular variations. Several mature specimens derived from the same stock were then subjected to different conditions of heat and cold and moisture. As the colour and pattern is fully developed by the time maturity is reached, external conditions acting afterwards are unable to change it. The beetles themselves, therefore, showed no sign of change, but the germplasm within had nevertheless been modified. In consequence of this, the young beetles whose parents had been exposed to heat and drought were markedly paler in colour than were their parents. The pallor was no indication that they were deficient in vitality; they were just as healthy as the rest. The

germplasm had been altered in some unknown way, so that less external pigment was developed, and the alteration was apparently a permanent one. When the pale young beetles themselves reached maturity they were bred together and produced offspring like themselves, and so long as the experiment was continued the paleness was exhibited in each succeeding generation.

Many other varieties of offspring were produced by the action on the parent form of different external conditions, and these, when produced, bred true in the same way as the pale ones. The amount of pigment was not the only thing affected, but the pattern in which it was arranged was in some cases altered also.

The experiments as far as they go are probably the most certain indication hitherto afforded that the germplasm, apart from the soma, can be permanently modified by the action of the environment. But few biologists would accept them as a proof that it normally is so affected. Until a great deal more definite evidence has been collected it would be unsafe to give as decided an answer to this question as was given to that concerning the inheritance of somatic modifications.

The other division of the problem—namely, the inquiry into the effects produced on the child during intra-uterine life by the acts and habits and condition of its mother, is an

important branch of the science of Eugenics. It is, however, too purely a medical question for discussion here.

There are certain other special circumstances acting before the birth of an individual which it is, or has been thought, determine his nature to some extent or in some way. Among these may be classed his birth rank among his brothers and sisters. Are the first-born and second-born members of a family likely to be better or worse in any respect than those born later, and what peculiarities, if any, distinguish the last few members of a large family? Professor Pearson's answer to the first part of the question is—that the first and second born children are more likely than the rest to be tuberculous, neurotic, insane, or to have criminal tendencies. If this is true, then the reduction in the size of families which is now taking place will have a directly harmful action on the race, apart from any effect which it may produce by selecting for reproduction the worse stocks rather than the better, since in small families a larger percentage of members are necessarily first-born or second-born than in large.

The type of evidence on which Professor Pearson's contention rests is as follows:—The Crossley Sanatorium at Frodsham is filled with lower middle-class and working-class patients suffering from consumption,

who come mostly from Manchester and, to a lesser degree, from Liverpool and its neighbourhood. From the records kept of the family histories of the patients it is possible to tell how many came in each particular place in their families. It was then found that of 381 patients, 113 were first-born, and 79 second-born. When the patients and all their brothers and sisters, living or dead, are taken together, it was found that in the 381 families there were 381 first-born and 366 second-born. Dividing these numbers by the average number of children per family, one arrives at the number of first-born and second-born, which, according to the theory of probability, one would expect to find in a sample made up by picking one child at random from each family. The numbers are 67 and 64. The 381 Sanatorium patients may be regarded as a sample selected by consumption, one from each family, and among them the corresponding numbers are 113 and 79—that is to say, about $1\frac{3}{4}$ times as many first-born and $1\frac{1}{4}$ times as many second-born, as in the random sample of the same size. As the differences are too large to be due to chance, they appear to show that consumption does not pick at random, but selects more particularly the first-born and the second-born. With regard to the third and later born members the differences were reversed, there being fewer of these among

the patients than would be the expectation if the latter were drawn by chance, one from each family.

An examination of the families of criminal and insane persons gives a concordant result, but before attributing it to any mysterious inferiority on the part of the first and second born, it is necessary to consider the possibility of its being due to some quite commonplace and easily intelligible cause. Two such causes have been suggested. The first is that infant mortality is highest among the later born members of a family, particularly in the classes from which the patients at the Crossley Sanatorium and the criminals and lunatics dealt with were drawn. In consequence of this, among those children who survive infancy the first and second born will be more numerous than among the whole number of children. It is necessary to survive infancy in order to be eligible for sanatorium treatment or to become a criminal or a lunatic. Thus, if the tuberculous patients, criminals, and lunatics were drawn *quite at random* from those members of the family who survived infancy, we would expect to find among them an excess of first and second born. The other cause is suggested by Dr Ploetz[1] in the following words:—'Among the children of a number of marriages taken

[1] Dr Alfred Ploetz, *Neo-Malthusianism and Race Hygiene.* Read before the Eugenics Congress, 1912.

at random, there are a good many children of parents who died early, consequently there is a high proportion of children who represent early members in birth rank, and principally first, second, and third born. Because of the death of one or both parents there could be no later born. First, second, and third born children, therefore, come in a far greater percentage from early deceased, that is on the average weaker parents, than do the later born, and they will therefore inherit in a higher degree the weaker constitution of their weaker parents.'

It is easier to believe in the truth of these two explanations than to accept as fact the view that in ordinary families the later born children are mentally and organically of sounder constitution than the earlier born.

The evidence on which the assertion is based, that infant mortality is highest among the later born members of a family is discussed by Dr Ploetz in the paper quoted. In a group of unselected lower-class marriages analysed by Geissler, which gave rise to 26,000 births, among the first four children of each marriage the percentage who died during the first year of life fell between twenty to twenty-three, for the fifth-born it was twenty-six, and it rose steadily after this point, so that sixty per cent. of the twelfth-born did not survive for one year. Dr Ploetz expresses the opinion that excessive

mortality among the later born is due largely to the fact that in a poor home where the family has become large the economic conditions grow worse, and such children as are born receive less attention and care than when the family was smaller. Among royal families where, presumably, the conditions are the best possible for all the children, there is no noticeable difference in mortality among the first nine.

If all the facts are taken together, the safest conclusion to draw seems to be that children are not directly affected to any marked extent by their place in order of birth.

Two other environmental agencies, according to popular belief, may determine or modify innate characters. These are 'Telegony' and 'Maternal Impressions.'[1] The theory of telegony, if applied to mankind, would mean that if a woman had a child by one husband and subsequently another child by another husband, the peculiarities of the first husband would exert an influence, not only on his own child but on the other man's. The supposed instances are for the most part derived from the breeding of animals, and are largely due to mistakes in the records of parentage. A scientific breeder of fowls, on whose well-ordered farm telegony was unknown, has defined it when exhibited

[1] Professor J. A. Thomson includes in his *Heredity* an interesting discussion of these theories.

by hens as 'she flew over the fence.' The definition is rich in meaning though poor in syntax. If one supposes that she flew over in secrecy in order to consort with a previous and preferable mate and then flew back again, we can well understand how a 'clear case' may have arisen.

Although not all the better authenticated instances are of this kind, other explanations which accord better than telegony with generally accepted biological views are invariably forthcoming, and one may be fairly safe in asserting that the Eugenist may disregard the possibility of the environment acting for good or evil through this medium.

Of the theory of 'Maternal Impressions,' early mention is made in the Bible. The story is told in the thirtieth chapter of Genesis, how Laban and his son-in-law Jacob agreed that the latter's wages should be 'all the speckled and spotted cattle, and all the brown cattle among the sheep, and the spotted and speckled among the goats.' But before Jacob could get possession of any of them, Laban picked out from among his flocks and herds every beast that answered to this description and gave them to his own sons. So 'Jacob took him of rods of green poplar, and of the hazel and chestnut tree, and pilled white strakes in them, and made the white appear which was in the rods. And he set the rods which he had pilled before

the flocks in the gutters in the watering-troughs when the flocks came to drink, that they should conceive when they came to drink. And the flocks conceived before the rods, and brought forth cattle ringstraked, speckled, and spotted.' Jacob separated out this lot for his own portion, and afterwards, 'whensoever the stronger cattle did conceive,' he laid them before the rods, so that their offspring should be his, while the remainder he left to Laban.

At the time when this narrative was written, the belief that animals would resemble some object placed conspicuously before their mothers during pregnancy must have been a common one, as the story is told without comment or any suggestion that something unusual had happened. At the present day the belief is still common, but it is held more with regard to human beings than to other animals. Fresh instances are constantly being reported and talked of in which a woman with child either lets her mind dwell on some object, or else receives some violent emotional shock from seeing something which startles or frightens her, with the result that her child when born has some points of resemblance to the object which has been in her mind.

Hearsay reports of a kind quite inadmissible as evidence are usually the only warrant for such stories; but in those cases in which it is possible to get an authentic account of the

facts, it is generally found that the resemblance noted is of the most slender description and easily explicable on the assumption that it is due to coincidence. The number of children who are born every day is very large, and their mothers in the months before they are born are particularly liable to receive shocks and frights from events which would not otherwise disturb them much. Under these circumstances it is nothing to be wondered at that every now and then a child should be born with some birth-mark or common defect which suggests the cause of the shock, or of one of the shocks, to which its mother has been subjected during her pregnancy. It should also be remembered that a particularly strong and protracted emotional experience of the mother may well have some effect on the nutrition of the child, as it depends for this on her circulatory system, which is very readily influenced by emotional disturbances. It is therefore possible that certain stigmata which are often reported to be due to 'maternal impressions' are in reality due to defective nourishment before birth.

In the present state of our knowledge it would not be far wrong to say that 'maternal impressions' are exceedingly unlikely to influence the characters of the human race, either for good or ill, by impressing on children still unborn the likeness of the objects which caused them.

SUMMARY OF CHAPTER

Some observations and inferences are brought forward which appear to show that 'nature' has a wider range of influence than 'nurture' in determining the development of the individual. For example, Galton found that those pairs of twins who were in early childhood closely similar to one another often retained the similarity even when exposed after childhood to different conditions of life; on the other hand, those who early showed contrasts, when brought up under almost identical conditions in childhood, did not grow more alike.

Professor Pearson and Miss Barrington, by statistical methods, have shown that the condition of the eyesight is determined to a large extent by heredity, and is not adversely affected in children by bad home conditions. Dr Heron found that intelligence in school children also seems almost unaffected by defective physique or an unfavourable home environment. Some matters of common knowledge are mentioned, which seem to indicate that the effect of the environment of any individual is strictly limited by his natural capacity.

The various ways in which outside influences acting before the birth of an individual may affect him are next discussed. Some of Tower's experiments on beetles are briefly described to show the possibility of the

germplasm being permanently altered by external conditions. Doubt is expressed concerning the poisoning of the germplasm by parental alcoholism; the greater liability of first-born and second-born members of families to become tuberculous, insane, or criminal; 'Telegony' and the theory of 'Maternal Impressions.'

CHAPTER X

THE SELECTIVE AGENCIES

A.—*The Differential Birth-rate and the Death-rate*

THE Selective Agencies which may improve or impair the inborn qualities of future generations either physically or mentally are those which cause a relatively rapid increase or decrease in the numbers of particular nations, races, or classes, or of the possessors of some definite good or evil quality. All such agencies must act by establishing, directly or indirectly, a differential birth-rate or a differential death-rate. Their study may be approached most conveniently by considering and comparing the action of the birth-rate and the death-rate.

The birth-rate and the death-rate are usually stated, by those who deal in vital statistics, as so and so many per thousand per annum. If the population of a country

in a given year numbered twenty million persons, and half a million births were registered during the year, the birth-rate for that year would be twenty-five per thousand, and if the deaths recorded were half as numerous as the births, the death-rate would be 12·5 per thousand. The rate of natural increase in a country is the amount by which the birth-rate exceeds the death-rate; it is different to the actual increase, for the latter is affected also by immigration and emigration.

In estimating the proportionate extent to which different nations are contributing to the population of the world it is simplest to consider the rate of natural increase. This can only be ascertained accurately for countries in which a regular system of registering births and deaths is in force. Among these, the increase in New Zealand is the most rapid, with a rate of 18·1 per thousand [1] (in 1909); it is closely followed by New South Wales and Queensland, in which the numbers are, respectively, 17·3 and 17·5. South Australia is a little way below with 15·4. Then comes Prussia with 14·8, and Victoria with 13·4; in England and Wales, Scotland, Italy, and Hungary, the rate is between 11 and 12. In Spain it is 9·2, in Ireland 6·3, while France comes lowest on the list with 0·3.

[1] These numbers are taken from Newsholme, *The Declining Birth-rate.*

If one turns from the figures to consider the causes of the differences indicated, the most obvious is that the now notorious decline in the birth-rate, a phenomenon to be observed in all civilised countries, began at different times in different places, and has consequently affected the diverse nationalities to a varying extent. In France, where the rate of increase is so low that the population may be regarded as practically stationary, the decline first started and has gone farthest, and the tendency to a diminished rate of increase thus established has not been counteracted by any very marked decline in the death-rate.

The Australasian colonies do not owe their high position in the list to any very great fertility among their inhabitants, but to the fact that their death-rate is very low. The low death-rate is not due entirely to exceptionally healthy conditions, but partly to the immigration of large numbers of young and healthy people. In Hungary the birth-rate, though it has been considerably reduced in the last thirty years, is still the highest of those recorded; but as the death-rate is also very high—25·1 per thousand, as compared to New Zealand's 9·2—the rate of natural increase is hardly greater than in England, where both birth-rate and death-rate are more than 10 per thousand lower.

If one compares England and Prussia, one

finds that in the latter the rate of increase is higher by 3·7 per thousand. The difference in the actual birth-rates is higher still, Prussia having a rate 31·8 to England's 25·8; but the mortality, particularly the infant mortality in towns, is so much higher in Prussia that a great deal of the excess is wiped away. Havelock Ellis[1] brings forward reasons for the belief that in a few years' time the rate of increase of the German population will be less than the English. The birth-rate of Berlin is already lower than that of London, and generally speaking the average number of children per family in German towns is less than in English towns of the same size. The rate is brought up by the inhabitants of the country districts, who are rapidly becoming relatively less numerous, while the urban population is fast increasing.

Another comparison of special interest is that between the white and yellow races. Those who fear 'the Yellow Peril' picture to themselves a China swarming with countless and rapidly increasing myriads of people, all able to support life in tolerable comfort on a quarter of the weekly wage which would barely maintain a European labourer. If this picture were correct, we might well expect either a peaceful invasion, which would gradually but surely replace the white races by the yellow; or if this were prevented by

[1] Havelock Ellis, *The Task of Social Hygiene.*

enforcing drastic laws against the immigration of the Chinese, then an invasion of another kind by armies, trained in scientific warfare, careless of death and inexhaustible in numbers.

There are no statistics available to tell one whether indeed the steady increase postulated is actually taking place or not, but Havelock Ellis has been able to collect evidence which should free one's mind from apprehensions of the kind just alluded to. From the testimony of doctors practising in China, it appears that the number of children born is exceedingly large, but that the percentage of those who grow up is very small indeed. Lack of sanitation and infanticide lead to a mortality rate which is estimated by some authorities to be as high as 90 per cent. of all children born. There are signs that Western ideas are likely to penetrate into China and lead to better conditions, and if this occurs the death-rate among children will undoubtedly go down; but the birth-rate will also probably be affected in a corresponding manner, so that we have little to fear in either case from the prospect of an inordinate growth in the numbers of the Chinese.

It seems even more unlikely that the world will be overrun by Japanese. The birth-rate in Japan in 1901-2 was 36 per thousand, but has since then been falling, and meanwhile the

death-rate has risen to 24 per thousand, so that the natural increase rate of the Japanese is now about the same or less than our own. The rise of the death-rate may be due largely to effects of the Russo-Japanese War, and, if so, it is likely to fall again. But even in this case it does not appear probable that a high rate of natural increase will result.

From this brief survey it should appear that although we may be able to measure the rate at which populations of some particular countries are tending to multiply by reason of their own fertility, yet it would be impossible to form even the roughest estimate as to what changes in the proportions of the various races on the face of the globe will be seen during the next hundred years. Owing to the fact that the present rapid fall in the birth-rate started in different countries at different times, and that it has fallen in different degrees, we are now in a transitional stage, and no one can say when, if at all, the birth-rate and the death-rate in different places will become fairly constant. Till that occurs, little faith should be placed in prophecies.

With regard to the causes of the declining birth-rate itself much has been written. The immediate problems which present themselves may be indicated by the following questions:—Is the decline due to the fact that fewer people marry? or that people marry

later in life? Does it depend on any lessening of the physiological capacity of women to bear children or of men to procreate them; or is it brought about by the deliberate intention of parents to limit the size of their families? It would be out of place here to enter into a detailed discussion of these points; it is obvious that all the four causes suggested may operate at the same time, but there is little doubt that the conscious limitation of families is the predominant factor. After assigning their proper share to each of these agencies, those who would go deeper into the question must determine the why and wherefore of it. Why, for instance, do people limit their families more than they used to? Some say it is because they are more selfish than they used to be, and additional children would mean the sacrifice of luxuries or even of what are regarded as necessary comforts; others, that it is due to the growth of social consciousness—a feeling of responsibility towards their children and towards society. Others, again, attribute it partly to the factory acts, which have, by placing restrictions on child labour, to a great extent diminished, among the industrial classes, the value of children to their parents as a source of income. All these reasons may have in them an essence of truth. Different motives may move different people to do the same thing at the same time, when once the

possibility of it is suggested to them; and it is a commonplace to say that the motives of individuals are rarely unmixed.

The relative increase or decrease of the racial constituents of a nation is a subject of great importance which has only been studied very little. It is a problem which concerns particularly countries where there is a constant influx of immigrants, for in these the greatest intermingling of races occur. In the United States the birth-rate of the native-born population appears to be on the whole very low and the average size of the family very small, while the families are larger and the birth-rate higher among the immigrants, who thus make a double contribution to the increase of the population. No general statistics are available to show this, but for some individual States detailed and reliable figures have been prepared. Of these, the most recent are those of Hoffmann,[1] based on the census returns of 1905 for the State of Rhode Island. He found that the average number of children for each married woman was 3·35 among the foreign born, and 2·06 among the native born. The averages for the individual nationalities represented among the foreign born were:—French-Canadians, 4·42; Russians, 3·51; Italians,

[1] F. L. Hoffmann, *Maternity Statistics of the State of Rhode Island, State Census of* 1905. Read before the First International Eugenics Congress.

3·49; Irish, 3·45; Scotch and Welsh, 3·09; English, 2·89; German, 2·84; Swedes, 2·58; English-Canadians, 2·56; Poles, 2·31. In whatever way the married women are compared, and whatever factors, such as difference in age, are taken into account, the result is the same, that the foreign born are shown to be much more productive than the natives, and this greater productiveness is not counterbalanced by a much greater infantile mortality. At the time of the census, 75·7 per cent. of the children of the former survived, and 79 per cent. of the latter—a difference quite insignificant in relation to the difference in the number of births. As the foreign born were almost a half of all the married women, the fact that the average numbers of their children is more than 50 per cent. higher than among the native born is one of some importance in considering what will be the future constituents of the population.

The Massachusetts State census for 1875 and 1885 was conducted in such a way as to allow a similar comparison to be made, and the conclusion drawn from it was essentially the same. The average number of children to each married woman among the American born was 2·7, and among the foreign born 4·5. Owing to the general decline in the birth-rate, both these numbers are larger than those obtained from the Rhode Island census of 1905; but in 1885 the figures

there were almost the same as in Massachusetts.

A curious contrast in fertility is shown between the French resident in France and those whose ancestors emigrated to Canada. It has just been noted that the latter after moving on from Canada to Rhode Island are the most prolific of the immigrants into that State, and in Canada itself the French are undoubtedly multiplying at a greater rate than the English. The most probable cause of this contrast is the greater influence of the Roman Catholic religion in Canada than in France.

The nature and number of the emigrants into the younger countries and colonies is to a large extent determined by the rate of natural increase of the older communities in more densely-populated lands. Thus the changes in this respect shown by European countries since the decline of the birth-rate first set in have had a considerable influence on the nationalities represented among the many immigrants who yearly enter the United States. According to Havelock Ellis, the North European contingent, which was formerly 90 per cent. of the whole, has since 1890 steadily sunk, and the majority now belong to the Central, Southern, and Eastern European stocks. The rate at which they multiply after settling in their adopted country, no less than the nature of the fresh

arrivals, will determine the racial character and mould the evolution of the United States.

The older countries which they leave have in their time been filled with emigrants from other parts, who have come sometimes as conquering armies and sometimes as peaceful and beneficent invaders, teaching new industries and enriching the lands in which they settled. No European nation is a homogeneous whole, all are everchanging groups of racial constituents incompletely blended. As these elements severally wax and wane, the mental, moral, and physical characters of the nations change, and the changes may be reflected in their history. A speculative attempt to interpret some phases of the history of Europe in this way has recently been made by Mr and Mrs Whetham.[1]

The racial elements which they distinguish as having been the principal constituents of the European population during historical times are three. First, the Mediterranean race. It is 'short of stature, dark of complexion and hair, long skulled, vivacious, gregarious, and one may perhaps add at once restless and easy going.' It may be recognised now in a fairly pure condition in

[1] W. C. D. and C. D. Whetham, *The Influence of Race on History*. Read before the First International Eugenics Congress. 1912.

Ireland, Wales, Cornwall, and parts of the West of Scotland. Secondly, the Armenoid race. This is of medium stature, medium colouring, and has a round skull. Thirdly, the Northern race. This is tall and long skulled, and in its pure condition blue-eyed and fair-haired. It is vigorous, loyal, determined, and persevering, and it loves adventure. It may be found in its greatest purity in the Scandinavian peninsula and around the Dutch and English shores of the North Sea.

The Whethams attribute the supremacy of Greece and Rome to a happily proportioned mixture of these races where the Northern provided the directing power. They see the cause of the decline and fall in the gradual dying out of the governing race, who suffered in numbers more than the others through losses in war and a lowered birth-rate, and were swamped by intermarriage. The Renaissance in Northern Italy they trace ultimately to the introduction of the right proportion of the Northern race, derived from the barbarian invaders of the later Roman Empire.

Our present social conditions favour the Mediterranean rather than the Northern race. The latter are more numerous in the classes among which the birth-rate is lowest and the former live more readily in the towns, and the towns are gradually absorbing a

larger and larger proportion of the whole population.

From a consideration of the relative increase or decrease in the racial elements we can pass to the related questions concerning the social classes. It has long been recognised that the birth-rate among the richer, which are essentially the same as the socially superior sections of the community, is lower than among the poorer. Sixty years ago[1] such a difference was already discernible, but it has become much increased through the accession of new factors in addition to those at that time operative. Then it was probably due wholly to the fact that marriages were usually contracted at a later age among the richer classes than among the poorer. This is still the case, but now, even when it is fully allowed for, a conspicuous difference remains. A difference of productiveness of this kind has been observed in most of the more important cities of Europe. Bertillon worked out the number of births each year for every thousand women between the ages of fifteen and fifty for different quarters in Paris, Berlin, Vienna, and London. The following table summarised his results,[2] published in 1897 :—

[1] David Heron, *On the Relation of Fertility in Man to Social Status, and on the Changes in this Relation which have taken place during the last Fifty Years.* 1906.

[2] Quoted from Newsholme and Stevenson, *The Decline of Human Fertility.* 1906.

	Paris.	Berlin.	Vienna.	London.
Very Poor Quarters	108	157	200	147
Poor ,,	95	129	164	140
Comfortable ,,	72	114	155	107
Very Comfortable ,,	65	96	153	107
Rich ,,	53	63	107	87
Very Rich ,,	34	47	71	63
Average .	80	102	153	109

The relation which the birth-rate in different Metropolitan boroughs bears to their social and economic conditions has been studied more recently by Heron, and by Newsholme and Stevenson.

Heron, using the correlation method, found that in London the birth-rate per 1000 married women, aged fifteen to fifty-four, is highest where the conditions show the greatest poverty—namely, in quarters where pawnbrokers abound, where unskilled labour is the principal source of income, where consumption is most common and most deadly, where pauperism is most rife, and, finally, where the greatest proportion of the children born die in infancy. The correlation coefficients show that the association of these evil conditions with the relative number of children born is a very close one, and if the question is put in another way, and the calculations are based on measures of prosperity instead of on measures of poverty, a high degree of correlation is found between prosperity and a low birth-rate.

It must not be supposed that the high rate

of infant mortality, which almost invariably accompanies a high birth-rate, either in London or elsewhere, goes far towards counteracting the effects of the differential birth-rate. Where infant mortality is highest the average number of children above the age of two for each married woman is highest also, and although the chances of death at all ages are greater among the inhabitants of the poorer quarters, their rate of natural increase remains considerably higher than that of the inhabitants of the richer.

From the detailed study of the figures made by Newsholme and Stevenson, conclusions essentially the same as those of Heron can be drawn. But as their results are in some ways more instructive than his, it is worth while to give some account of them also.

Their first step was to divide the London boroughs into six groups according to the average number of domestic servants for 100 families in each. This is probably as good a measure of prosperity as any other. They then determined the total birth-rate of the population in each group, and arrived at the following figures :—

Group				
I.	10 domestic servants	for 100 families		34·97
II.	10–20	,,	,,	38·82
III.	20–30	,,	,,	25·99
IV.	30–40	,,	,,	25·83
V.	40–60	,,	,,	25·11
VI.	over 60	,,	,,	18·24

In order to find out how far the differences shown by these figures are due to differences in the percentage of women who marry in each and the age at which they marry, they corrected the figures in such a way as to make them represent what the birth-rates would be in each group, if the proportion of wives of each age to the whole population comprising the group was the same as it is in the whole of England and Wales. The 'corrected' birth-rates thus obtained were as follows:—

Group I.	31·56
Group II.	25·82
Group III.	25·63
Group IV.	25·50
Group V. . . .	25·36
Group VI.	20·45

It will readily be seen that the effect of the correction has been to reduce the difference between the two extreme groups by about one-third, showing that to this extent it is due to the way in which they differ as to the average age and number of the women who marry. Further, Groups II., III., IV., and V. have all been brought to about the same level, with a corrected birth-rate about half-way between the highest and the lowest. This shows that there is no gradual decrease in fertility associated with a gradually increasing grade of prosperity, but that three sharply divided classes may be distinguished.

A very poor class with a high degree of fertility, to which about a quarter of the population of London belong, a rich class with a low degree of fertility, and a class intermediate in both respects. The comparison between the corrected birth-rate shows the degree in which the voluntary limitation of families was practised in different parts of the Metropolis about ten to twelve years ago. There is reason to believe that if a similar comparison were made now, the difference between Group VI. and Groups II., III., IV., and V. would be less marked, for it is thought that the practice is spreading among the lower middle and upper part of the working classes.

Eugenics is less directly concerned with this side of the question than with the relative rate of increase of the different classes. This may be found for the six groups in the usual way by deducting the death-rate from the birth-rate. The following figures for the rate of natural increase are then obtained:—Group I., 16·56; Group II., 13·89; Group III., 11·43; Group IV., 13·81; Group V., 10·29; Group VI., 5·79. The great difference between the rates in Group I. and Group VI. will be noted at once. The fact that Group IV., which consists of Wandsworth, Lewisham, and the City of London, stands out above Groups III. and V. is due to the fact that its death-rate is the lowest of any.

The figures show in a manner which hardly admits of any doubt that in London at any rate the inhabitants of the poorest quarters—over a million in number—are reproducing themselves at a much greater rate than the more well-to-do.

The French census of 1906 was conducted in such a way as to throw light on the comparative fertility of people of different occupations. Monsieur March,[1] in analysing the data obtained, used as a basis of comparison the average number of children per 100 families in which the parents had been married for twenty-five years, or in which the head was sixty to sixty-five years old. The results 'confirm what has previously been learnt by researches as to the influence on fertility of social status, social surroundings, and income.' Many other facts of importance can be ascertained from them, but they cannot be conveniently summarised here.

'The fact that the birth-rate is much smaller in higher than in lower social strata,' Newsholme remarks, 'has given rise to many Cassandra-like utterances.' He goes on to suggest reasons for disregarding them. But Cassandra was a true prophetess, and her warnings were only ineffectual because they

[1] *La Fertilité des Mariages suivant la Profession et la situation sociale*, par M. Lucien March, Directeur de la Statistique Générale de la France. Read before the Eugenics Congress. 1912.

were disregarded by the Newsholmes of her time and city.

The facts noted should receive the gravest consideration. They should not be lightly set aside because it is uncertain whether or to what degree the lower social strata are inferior in respect to inheritable mental or physical qualities to those above them, but an attempt should be made to collect and consider evidence on this point. Such data as are at present available for discussion all tend to show the average superiority of the upper classes. If mental capacity is inherited no other result could be expected. In every walk of life there are opportunities for a man to rise, and in most the qualities which will enable him to take advantage of them depend to some extent on mental capacity.

It may be that the opportunities sometimes favour moral attributes of an anti-social kind, but they never favour a weak intellect; the predatory millionaire is perhaps ethically of the same standing as the burglar, but intellectually he far surpasses him. It may be that in some cases sheer good fortune forces one man up, and sheer ill fortune brings another man down. It is also possible that some deficiency in hardness of character keeps success away from a man who would otherwise win it; but if, after thirty years, one were to divide into groups, according to their rise or fall in life, men who had set

out together at the same time and from any given position in the social scale, there is surely no doubt that native ability would be present on the average to a higher degree in the group which had risen than in that which had merely maintained its position, or that the latter would contain more of it than that which had actually sunk.

To turn to arguments of a different nature, the London County Council sets up educational ladders in all parts of the Metropolis, but finds it difficult to get boys to go up them. The number of children in the schools maintained by the rates who are bright enough to make it worth while to give them the scholarships provided by the London ratepayer is hardly enough to fill them. No difficulty is experienced in filling those at the Public Schools or University with boys of a very respectable level of intelligence, whose fathers belong mostly to the professional classes. This is a rough and vague method of comparison which, though not in itself very convincing, is put forward as deserving of thought.

It is to the investigations of the experimental Psychologists that one may look most hopefully for the facts that will enable one to form a definite decision as to the relative intellectual worth of the raw material produced by the different social classes. At present not enough is forthcoming to form

a really reliable basis for an opinion, and in its absence we should abstain from any dogmatic assertions as to the superiority of one or another. But, while recognising that certainty is far off, one must be guided by probability, and the probability appears to be that the classes who are providing more than their fair share of the coming generations are actually the mentally inferior classes.

It is urged by some people that the differences in productiveness now shown are only temporary, and that in the course of a few years, owing to the downward spread of the habit of restricting families, the birth-rate will resume a uniform level throughout the whole community. This is a possibility, but it would be unwise to assume that it will ever be an actuality. At present, all one can say is that very small families are common among the better-class working men. But there seems to be no evidence that in the bottom stratum this will ever be the case.

B.—*Selective Mortality from Special Causes*

Dr W. C. Wells, in the year 1818, noted that negroes and mulattoes enjoy an immunity from certain tropical diseases, and concluded that they owed it to the fact that individuals unadapted to withstand them would be weeded out by death. And thus,

in the same way that domestic animals are improved by the conscious selection of their breeders, varieties of mankind suited to the localities in which they live would be produced by the selective action of the indigenous diseases.

More recently the same idea has been developed by Dr Archdall Reid.[1] His view, like that of Dr Wells, is that the mortality from a disease is a selective one. It tends to kill those who are by nature unable to resist it. If the power of resistance depends on some inheritable property of the body, it will be transmitted by those who survive the attacks of the disease to their children, and if these again are exposed to the chances of infection the less resistant will again succumb, and thus be less likely to leave children behind them than those who were better equipped for the fight.

A number of particular diseases are discussed by Dr Archdall Reid, and the following passage may here be taken as an example. With regard to malaria he writes, 'Man's evolution against malaria is more striking and conspicuous than that occasioned by any other disease, and that for two reasons. First, because in many districts infested by its microbes, it is so prevalent and so virulent that no man resident in them escapes infection unless he is immune, nor death unless

[1] Archdall Reid, *The Principles of Heredity.* 1905.

he is resistant. The elimination of the unfit, therefore, has been very thorough, and presumably it has been very prolonged. . . . Secondly, the illness occasioned by the disease is of a very sudden and marked character; and, therefore, observers are easily able to contrast its effects on individuals of different races, and to perceive how much more resistant are those races which have prolonged experience of it than those to which it is strange. This fact is admirably brought out in the following table :—

In Ceylon there died of malaria fevers per 1000 *of the population*—

Negroes . .	1·1	Natives of Ceylon .	7·0
Natives of India	4·5	Europeans (English)	24·6
Malays . .	6·7		

'Just as regards malaria, so as regards tuberculosis, the resisting powers of any race is precisely in proportion to its past familiarity with the disease.'

According to the views expressed here, it appears that although the selective nature of deaths from disease do not have any general and direct Eugenic value, they do to some extent adapt mankind to the environment which produces it. The action of a disease on human races is curiously paralleled by the effects which the drugs given to drive it away have on the microscopic

organisms which cause it. As in the one case the race of men gradually becomes able to withstand the poison produced by the microbes, so in the other the race of microbes often acquires the power to withstand the poison administered by the man.

Second to disease, the principal cause to which a selective action may be attributed is War.[1] Havelock Ellis says, 'It is a remarkable tendency of the warlike spirit . . . that it tends to exterminate itself. Fighting stocks, and people largely made up of fighting stocks, are naturally killed out, and the field is left to the unwarlike. It is only the prudent—those who fight and run away—who live to fight another day; and they transmit their prudence to their offspring.' We would venture to question this statement, and to point out that those who fight and run away, by so doing, probably prolong the war and increase the number of its victims, while reckless fighters, suitably led, may win so quickly that it is soon over. The sacrifice of life in war-time is due not so much to the lust for battle of those who die, but to imperfect sanitation and the blunders of the generals. The selective action of modern warfare is probably more concerned with physique than with moral qualities.

[1] Dr David Starr Jordan is the author from whose work the idea of the selective agency of war is ultimately derived.

The tendency which great wars may have to cause deterioration in the physical characteristics of the nations engaged was discussed at the Eugenics Congress by Professor Kellogg.[1] Its proof rests first, on the 'determination of the character of that part of the population especially exposed to the selective mortality of war,' and secondly, on 'the determination of certain actual results of this selection.'

European armies consist of men who come up to a certain standard of physical development. The standard may be a low one, but in countries where military service is compulsory, those who escape it by reason of their defective physique form a considerable proportion of the whole number liable to serve. In France and Germany, thirty to fifty per cent. of the conscripts are rejected as unfit for service because of undersize, infirmities, or disease; and in 1911, out of 64,000 men who offered themselves for enlistment in England, Scotland, and Wales, forty-five per cent. did not reach the required standard. These figures are a sufficient illustration of the fact that if a war occurs, the men who lose their lives in it, either in battle or from disease, will be on an average physically superior to those of the corresponding age who are not exposed to the risks. It is hardly necessary to insist that in

[1] V. L. Kellogg, *Eugenics and Militarism.*

a great war the number of the killed are by no means negligible, but form a quite considerable proportion of the populations from which they are drawn.

The actual results of war on national physique may be deduced from the recruiting records of the French Government, which have been kept in some detail from the beginning of the last century. The figures show that the great wastage of life for which Napoleon was responsible had its effect in the progressive decrease in average stature in the military levies of 1813 and onwards. But when the men who were born after the Napoleonic wars started coming, in the average stature rose again by more than an inch. Corresponding to these changes in stature were changes in national vigour, which, though less easy to demonstrate, had a more lasting effect on the health of the nation.

Far more numerous than losses in war are the deaths of infants from more or less preventible causes. The selective action of infant mortality is a question about which conflicting opinions are held, but about which there is little definite evidence. The conclusions arrived at by Mr Snow,[1] who made an elaborate statistical investigation of the subject, seem to point to the fact that it is actually the weakliest children who die in

[1] E. C. Snow, *The Intensity of Natural Selection in Man*. 1911.

infancy. Mr. Snow's results cannot, however, be accepted as established, and even if they were, one need not on that account suppose that heavy infant mortality has any beneficial effect, for it is more than probable that the conditions which produce it cause harm to those who survive, and result in the production of a less healthy family than there would have been if only the number left over had been born in the first instance, and the conditions had been good enough to permit the survival of all.

The Selective Marriage-rate and Sexual Selection

These two agencies must be briefly referred to. A Selective Marriage-rate is of importance in the way in which it affects the birth-rate. It may itself be due to Sexual Selection, or to regulations or customs which prevent or encourage marriage, of which examples are given in Chapter I.

There is reason to believe that the movement for the emancipation of women, which is rendered so conspicuous by its more grotesque manifestations, is wide and deep enough to have a well-marked influence in sexual selection, the marriage-rate, and the birth-rate. It owes its origin partly to the numerical excess of women over men, a condition which itself modifies sexual selection

by putting the choice of a mate rather in the hands of men than of women. Among the professional classes the movement has encouraged the spread of higher education among women. This appears to have led to decreased fertility among some of the most capable—a result probably not due to any decline of physiological capacity, but to the 'spinster influence' in education.

SUMMARY OF CHAPTER

The birth-rate and death-rate are considered, first, as agencies which may have an international significance in bringing about changes in the numerical relation between different nationalities and the population of the world.

Considering individual nations separately, their character may be altered either by the relative increase of some of the racial elements comprising them, or by the more rapid multiplication of particular social classes. Certain researches illustrating these points are described.

The selective action of disease, war, and infantile mortality are next treated, and, finally, reference is made to marriage-rates and sexual selection.

CHAPTER XI

SOCIAL CONTROL, AND SUGGESTIONS FOR A PRACTICAL POLICY

THE practical measures by which Eugenic principles may be applied are sometimes divided into two classes, called respectively positive and negative. Positive Eugenics aims at securing the multiplication of those individuals who are inherently above the average in physical, mental, and moral qualities. Negative Eugenics aims at preventing increase of the stocks from which persons inferior in these respects may be expected to be derived. This classification is open to a good deal of criticism, and the words positive and negative are hardly well chosen. The measures sometimes advocated under the heading of negative Eugenics are generally of a more positive description than any which could reasonably be suggested in the other category, and much that is most feasible in the proposals for an Eugenic policy cannot be entered in either class. For example, by the teaching of sexual hygiene and the promulgation of sane ideals in respect to marriage and procreation, it is endeavoured at the same time to secure that the maximum number of children shall be raised and reared

under the best possible conditions of parentage, and the minimum under the worst.

Therefore, in considering the methods by which the social control is or possibly can be brought to bear on the agencies which improve and impair the racial qualities of future generations, this classification will not be used, but the methods will be grouped according to the manner in which the control is exercised. The most important class comprises marriage laws and customs.

Marriage Laws and Customs

It is sometimes urged by persons opposed to Eugenics that it can only proceed by enforcing restrictions in marriage, and that such restrictions are either impossible or undesirable in that they would lead to worse results than those which they were designed to prevent. Two answers may be made to this objection: first, that restrictions in marriage form no necessary part of an Eugenic policy; secondly, that such restrictions may be and have been enforced with ease and without friction. In a paper on the subject, read by Sir Francis Galton before the Sociological Society in 1905, he reviews certain laws and customs which interfere with the free selection of a mate. The first of these is monogamy, a restriction not imposed by natural instinct, but owing its

origin to a consideration for social well-being. The majority of people belonging to those nations among whom monogamy is in force aquiesce in it with readiness, even if some rebel and form what are practically polygamous connections.

Secondly, 'Endogamy, or the custom of marrying exclusively *within* one's own tribe or caste,[1] has been sanctioned by religion and enforced by law in all parts of the world.'

Exogamy, which is the exact opposite of endogamy, has been as widely spread and is now practised largely by barbarians. Among the Australian bushmen the customs regulating marriage are both very complicated and very rigidly enforced, while the prohibition of marriage among kinsmen of some degrees, and celibacy voluntarily assumed from religious motives are familiar to all. Galton argues that if such restrictions as these have been submitted to, it would be possible among a people impressed with the virtues of the Eugenic ideal to enforce others which have for their object the improvement of the race.

Marriage laws, in so far as they concern themselves with the biological aspects of marriage, are discussed by Mr C. B. Davenport, in a paper communicated to the Eugenic Congress of 1912. He points, firstly, to the

[1] In civilised countries endogamy is practised, in that it is almost a universal custom to marry within one's own social class.

fact that in all civilised States persons related to one another in certain degrees are not permitted to intermarry, and he suggests that the prohibition arises from society's early and evil experience of the results of such matings. Records of the offspring of such incestuous matings as brother and sister, father and daughter, are forthcoming in considerable numbers at the present day, and would certainly seem to confirm the essential wisdom of the laws forbidding them. But when the degree of relationship is as distant as that of first cousins the case is much more doubtful. In Europe such marriages are allowed by the civil law of most countries, but in some, where the canonical law of the Roman or Greek Church is in force, they are prohibited. In Greece and Russia a man may not marry his first or second cousins or any relatives to the sixth degree. In Spain, marriage is not permitted to relatives of the fourth degree, which include first cousins, and in Austria also marriages of the latter are prohibited. It appears, however, that in all these countries dispensations can be obtained without much difficulty; and in America, where there are laws forbidding marriages between first cousins in sixteen States, it is questionable to what extent they are enforced. Such laws are bound to be ineffective unless sanctioned and supported by public opinion.

With the exception of religious celibacy, which could obviously never become universal among any people, the restrictive laws and customs hitherto mentioned are the less harsh, and therefore the more readily submitted to, in that they do not prevent any individual from marrying—they merely limit him in the choice of a mate. Some, however, actually in force, go further and absolutely prohibit matrimony to persons who do not reach to a required standard. Thus, according to Westermarck, among certain savage tribes a man is not allowed to take a wife unless he can show he is capable of supporting her. The proof of his ability differs from place to place, according to circumstances. Among certain Bechuana and Kafir tribes the prospective husband must have killed a rhinoceros; among the Dyaks of Borneo, and other peoples in the Malay Archipelago, the minimum requirement is the acquisition of a certain number of heads from foreign tribes, by the slaughter of their original owners. The same idea can be recognised in the marriage laws even of civilised countries, for in the American State of Delaware marriages of paupers are not permitted, and in Indiana no male who is or has been within five years an inmate of any county asylum or home for indigent persons is allowed to marry unless he can show that the cause of

his condition has been removed and that he can support a family.

In many countries, such as Austria, Switzerland, and the greater part of the United States, idiots or insane persons are not permitted to marry on the legal ground that they are incapable of making a valid contract; but in some the Eugenic principle is recognised by extending the prohibition to epileptics and other persons to whom this reason does not apply. The State of Washington goes furthest in this respect by not allowing 'Marriages of common drunkards, habitual criminals, epileptics, imbeciles, feeble-minded, or those who are afflicted with hereditary insanity, advanced consumption, or any contagious venereal disease.' It is obvious that this enactment has been made in order to prevent the reproduction of persons in the conditions mentioned, because it does not apply to marriages in which the female party is over forty-five years of age. In Kansas, in order to supplement the prohibition made for the same reason of the marriage of epileptics, imbeciles, feeble-minded or insane persons, a law has been passed making cohabitation between unmarried persons a criminal offence. There is no ground for supposing that any good can come from laws such as these. Even if it were possible to prevent by statute the marriage of epileptics and feeble-minded persons and

their like, illegitimate unions and the increase of prostitution would be the result, and there is abundant proof that laws are powerless to stop these evils.

Regulations permitting the annulment of marriages in which one of the parties has concealed some fact of importance concerning his mental or bodily health are in force in some countries, and have been recommended by the Majority Report of the recent Divorce Commission. They are in many ways of greater Eugenic value than prohibitions of the kind described, and inflict undeserved hardship on no one, but rather serve as a protection against it. In Switzerland a marriage may be rendered void 'by one of the spouses, where a disease, which seriously endangers the health of the petitioner or his descendants, has been concealed from him.' In Portugal and in Brazil a marriage may be annulled on the ground that a mistake has been made by one spouse owing to ignorance of a crime committed by the other before marriage, or of a previous incurable physical defect or any incurable contagious or hereditary disease.

The principle recognised in these regulations, that each party to a marriage has the right to know those facts concerning the bodily condition of the other which may affect him or his children, is carried a step

further in the following proposals laid before the Norwegian Storthing by Dr Mjöen[1]:—'That [in addition to the provisions at present embodied in the marriage law] there should be a declaration by each of the two contracting parties, made at a date not exceeding six months before marriage, in regard to whether either is subject to a disease or weakness which might have an injurious effect on the health of the other or of the offspring; and, further, that each declaration should be accompanied by a document signed by the parents or guardians of both parties, stating that it has been submitted to their notice, and that, consequently, they have had opportunity to raise any necessary objections or to make representations to the one or the other of the couple intending marriage. The declarations should be made before a physician authorised by the State.'

If this proposal were adopted, it would no doubt have to be enforced either by making punishable a false declaration made with intent to deceive, or by considering it a ground for the annulment of the marriage. It is intended primarily to protect women from marrying men suffering from venereal disease, but is capable of effecting other Eugenic objects. Thus the disclosure of

[1] Translated from *Nylaende* (Norwegian Journal of Women's Rights), quoted from *The Eugenics Review*, Vol. IV., No. 4, 1913.

epilepsy or a tendency to insanity might well be insisted on, and even in cases where both parties agreed to the marriage in spite of such defects they would be warned to take advice concerning the desirability of having children.

Sterilisation and Institutional Care

By sterilisation is meant the removal of power of reproduction. This may be accomplished by simple operations, which do not interfere with normal life in any way. In man they are attended by no sort of danger, but some risk is run in the case of women. It would be out of place here to discuss the nature of these operations; it is sufficient to point out that castration is not among them.

Laws permitting or enforcing sterilisation in certain cases have been passed in several States of the American Union, but up till quite recently it has been difficult to obtain information as to how they were working. The difficulty has now been removed by the action of the Eugenic Section of the American Breeders' Association in appointing a committee 'To study and report on the best practical means for cutting off the defective germplasm in the human population.' Though the wording of the terms of reference may raise a smile, by the naïve way in which a

practical problem is expressed in the language of a biological theory, the committee is a serious and business-like body, consisting of men of ability and experience, and assisted by specialists in all branches of relevant knowledge. Their preliminary report was communicated to the Eugenics Congress by the chairman, Mr Bleecker Van Wagenen, and contains an account of the American sterilisation laws and of the extent to which they have been enforced, together with a careful examination of the actual effects on the subjects of the operations involved. The eight States which have passed laws of this description, together with the dates in which they were passed are given as follows:—Indiana, 1907; Washington, 1909; California, 1909; Connecticut, 1909; Nevada, 1911; Iowa, 1911; New Jersey, 1911; New York, 1912. But at the present time their operation has been suspended as the question has been raised whether the constitution of the Union permits of such enactments by individual States. It thus happens that only in the case of Indiana and California have they ever been enforced. In Indiana a commission, consisting of three surgeons, is empowered to select for treatment from reformatories or other State institutions of a similar nature persons 'deemed by them to be unimprovable mentally and physically, and unfit for procreation.' During the year 1907 and 1908

125 operations were compulsorily performed, but in January, 1909, a new governor was elected opposed to such measures, and since then nothing of the kind has been done.

In California the persons subject are inmates of State hospitals for the Insane and homes for the Feeble-minded, inmates of State prisons committed for life or showing sexual or moral perversion, also those who have been twice committed for sexual offences or three times for other crimes. The selection is made on the recommendation of the superintendent or resident physician to a board consisting of himself, three general superintendents, and the secretary of the State Board of Health. Whereas in Indiana the motive of the State in passing the law is purely Eugenic, in California the principal object is the physical, mental, and moral improvement of the persons operated on. Although armed with compulsory powers, the board referred to has, as far as possible, avoided using them. In the majority of cases where the operation was indicated, the written consent of the patient's relatives was obtained. In some the decision was made by the patient himself, if he was mentally in a condition sound enough to render a reasoned consideration of the question possible. In all two hundred and twenty persons, ninety-four of them women, have been

treated in the Jeffersonville reformatory since November, 1910.

Besides inquiring into the nature of these laws, and the extent of their practical application, the committee took special pains to find out what physical or psychical changes were produced on the persons operated on, and whether any undesigned hardship or discomfort was inflicted or any risk entailed. They found that the operation usually performed on men is simple and practicable, that it is attended by no risk or discomfort, and does not interfere with the sexual functions except in attaining its object of preventing procreation. It does not appear to modify the mental or moral character in any undesirable way. There are three different operations of a parallel nature which may be performed on women, but none of them is wholly free from danger to life or of disturbance in other bodily and mental functions.

The enactment of these laws in America has not been due to any general demand for them. They were carried through owing to the enthusiasm of quite a small number of people among a public caring for none of such things. In some States where bills were introduced a hostile attitude taken up by one determined person was enough to prevent them becoming law. Sterilisation inflicted compulsorily under such a law as that of Indiana is in effect a punishment

imposed by a board which differs from a court of justice, both in its constitution and in the fact that the prisoner is not heard in his own defence or represented by counsel. As the first principles of justice are thus traversed, it is undesirable and unlikely that legislation entailing it will ever become at all general; indeed, it seems likely that it has already received its death-blow. But against sterilisation by consent there could be no objection on the ground described above, and it might be regarded in many cases as a desirable substitute for a lengthy incarceration in some institution. A typical case of this nature is brought forward by the committee, and will here be quoted.

'Case and family history of H., an inmate of the Boston State Hospital for the Insane. The patient is 42 years of age, a native of Ireland, had been committed to an insane hospital before coming to America. Good habits, steady worker, can earn ten dollars a week in low-grade shipping work. The wife of the patient is of a decidedly inferior make-up, but is a good mother, and keeps a clean and orderly house. She said they had had all the children they could provide for, and that they do not want any more, but realised that probably more would come.' Of the children which they had already had, four had died in infancy and three were feeble-minded, only one appeared to be alive

and normal. 'After a few months treatment it was found that the patient had apparently recovered, and was able to go back to the industrial world, and it was learnt that he could secure his old position at ten dollars a week. Meanwhile the patient was at the State expense and his family was depending on charity. The only objection to his release was the danger of propagating more children of the sort already produced. The operation was proposed, but he objected. The wife was brought in, and the patient, hospital authorities, and the wife held a conference. The operation was finally agreed to by the man, and was performed, and the patient discharged.'

Cases like this seem to show that there are occasions in which sterilisation can be performed without imposing hardship on any one, and almost with the certainty of preventing the birth of feeble-minded children, destined, if born, to be a burden to the community. Thus even in the present state of our knowledge of the laws of heredity it should receive consideration as a practical Eugenic measure. The only alternative which could effect the same object is some form of custodial care, either in an institution or under suitable guardianship. This has not the objection of being irrevocable, and has the positive merit of keeping safe those persons who would otherwise be likely to injure

themselves and others. It is indeed almost entirely on the latter ground that custodial care is proposed in such measures as the Mental Deficiency Bill, which was introduced into Parliament in 1912. This bill provided that certain classes of the mentally deficient might be placed in a special institution or under guardianship—namely, 'those who are found wandering about, neglected, or cruelly treated; who are charged with the commission of any offence, or are undergoing imprisonment or penal servitude or detention in a place of detention, or a reformatory or industrial school, or an inebriate reformatory, or who are habitual drunkards within the meaning of the Inebriates Acts, 1879 and 1900; also those children discharged at the age of sixteen from the special schools and classes for defective and epileptic children, for whom, in their own interest, the local education authority thinks such care desirable,' and one or two other vaguer categories.

This bill was opposed principally on the ground that it interfered with individual liberty, an objection which might be made to all laws made for the protection of society; no measure of liberty is possible for any one unless some bounds are placed to the liberty of all. Freedom is nothing to be desired in itself; but is only valuable as a condition antecedent to that companionship with others and to that employment of the mind or body

which bring happiness and completion to the lives of human beings. Where freedom leads to no such development, but merely to evil which spreads and grows, it destroys itself by forging fetters of crime and drunkenness, disease and vice. It is no brutal tyranny that aims at saving from such evils those who cannot save themselves.

Some other methods of social control may be considered more conveniently in the suggestions for a practical Eugenic policy, which will form the concluding part of this volume.

Suggestions for an immediate Eugenic Policy

It is sometimes urged against Eugenics by those who admit the soundness of its theoretical basis, that it is impossible to carry into practice any of the lessons which it would teach. There is no form of prophecy which has more repeatedly been falsified than assertions of impossibility. It is urged by others that a vastly wider and more exact knowledge of heredity is required before any practical steps may be safely taken. The answer to this is that the knowledge available at present is enough to justify a fairly wide programme, on which the acquisition of fresh knowledge must stand first.

There is ample knowledge to justify the introduction of a measure for the care and control of the feeble-minded and of moral

imbeciles—that is to say, 'persons who from an early age display some mental defect, coupled with strong vicious or criminal propensities on which punishment has little or no deterrent effect.' This control should be of a sufficiently effective and permanent kind to preclude the possibility of such persons propagating their kind.

The passing of such a measure is the only directly Eugenic legislation which can at present be advocated, and it may be urged more strongly on purely humanitarian grounds.

Another practical step which may be taken with safety is the examination of existing laws and customs in order to determine their effect on future generations. In particular, the incidence of taxation is a point to be considered; the Eugenist should advocate its adjustment in such a way as not to penalise parenthood among the self-supporting classes. The equity of this principle has already been recognised, though in an altogether inadequate manner, in the Finance Act of 1909, under which a rebatement of income tax for each child, amounting to seven shillings and sixpence per annum, is allowed to fathers of families with an income of under £500 a year.

But it is local rather than imperial taxation which places the heaviest burden on the family. The rates levied on house property may be considered to some extent as a tax on the children of the self-supporting, which

is levied largely for the purpose of rearing the children of those who either do not support themselves or do not do so completely. This condition arises because among the classes on whom the burden rests most heavily a man with a large family cannot economise by living in a small house, so he suffers first by having to pay a larger rent than would otherwise be necessary, and then is taxed according to the amount of rent he pays.

It is not suggested that Eugenists should immediately start an agitation for rating reform, but they should point out the manner in which some of the taxes or laws already in force tend to have a differentiating action on the birth-rate, and they should examine contemplated additions or alterations of the present system from the same point of view. Their immediate aim must be to impress the importance of these considerations on the persons responsible for the adjustment of taxation or the introduction of legislation, and also on the public who by their votes ignorantly exercise a vague and spasmodic control over Parliamentary action.

There are many other ways in which marriage and parenthood are discouraged among people who are generally able and efficient members of the community. Both private individuals and public bodies often find it convenient to offer some accommodation in part payment for the services of

employees. This accommodation is often so inadequate that the possibility of marriage is altogether precluded.[1] In other cases marriage is permitted, and it may be actually insisted on because it is convenient to employ a man and his wife together; but then the condition is often made that there should be no children, which are for this purpose described as encumbrances. Even when these degrading terms of employment are not insisted on, the house-room provided is often so deficient in space, light, and ventilation, that it is almost impossible to rear a healthy family in it. Eugenists should see to it that they are themselves free from reproach in this respect, they will then be in a position to reform others.

We can next turn our attention to the marriage laws, in which some alteration is to be advocated. Where one party to the contract conceals some disease or defect of a kind which is dangerous to the other, or is likely to be the cause of heavy mortality or serious defects among the offspring, the right of annulling the marriage within a certain time should be allowed. Whether insanity or any serious disease developed after marriage

[1] What has been said above does not apply to female domestic servants, because their occupation is for the most part not a life work, but merely a means by which they may subsist till marriage, when the occupations and duties which it entails in any case prevent their continuing in service.

should be a ground for divorce is a question which is more difficult to answer from the consideration of its Eugenic aspect; but on the whole it seems likely that divorce is more desirable in such cases than legal separation. The latter prevents both parties from re-marrying, and, in doing so, directly encourages the various kinds of illegitimate unions which are all likely to be dysgenic in one way or another. Its action is also harmful by being selective, because it is far more likely to prevent those whose actions are controlled by a respect for law and morality from having children, than those who merely aim at self-gratification.

The crude and impracticable proposal, that before being allowed to marry, it should be necessary to obtain a medical certificate of fitness, must next be mentioned. It has no serious advocates now, so the objections to it need not be discussed. But it has led to other suggestions for which a great deal may be said. The Norwegian scheme of health declarations before marriage has already been described in this chapter, and although there is little chance of its introduction into this country, yet something of the same kind, run on voluntary lines, might well be started. If, as the result of gradual education on these matters, public opinion sanctioned and supported such a scheme, it would be widely extended, because then

people would hesitate before marrying any man or woman who refused to make the required declaration, and thus it might have a valuable Eugenic influence.

But though something of use may be done by the modification of our laws and customs in these and in other directions, the most important task before the apostle of Eugenics is the dissemination of the Eugenic ideal. By this is meant the co-ordinated group of sentiments, aspirations, and desires, based on a right appreciation of moral and social values, which will lead those in whom they are implanted to enter gladly, but wisely, and with a sense of responsibility, on the duties and privileges of marriage and parenthood.

If its influence is to be effective, the right notions must be planted in the human mind while it is still young, and thus the suggestion has been made that Eugenics should be in some way introduced among the lessons learnt at school. How this should be done is a pedagogic question of much difficulty, on which the Eugenist as such can hardly be expected to express an opinion. His object must be to convert those whose business it is to guide the education of youth, and to supply them with the knowledge necessary for teaching the subject. The devising of practical methods of so doing must be left to them. To impress on a body of men and women who have the reputation of being

excessively conservative the desirability of teaching a subject so unlike any included in the old-fashioned school curriculum might seem a task of considerable difficulty; but it is lightened by the fact that already a strong movement is on foot among them for introducing instruction in 'sexual hygiene,' which is itself of direct Eugenic value. The object of this movement is to guard growing boys and girls from the unhealthy and vicious habits and thoughts into which they may be led during the development of their sexual instincts. Into lessons in sexual hygiene, if they are found to be valuable and practicable, Eugenics might well enter, as these lessons would form a fitting introduction to it, while it would supply them with a larger and more spiritual aim, such as might well commend itself to those whose time of life renders them particularly susceptible to the appeal of all that is spiritual and altruistic.

By the Eugenic ideal Love must be guided, and to it baser motives for marriage must be subjected. Those who are carelessly contented with our present manners and customs or fear too much the difficulty of modifying them are in the habit of expressing in hackneyed proverbs the view that Love cannot be guided or controlled. They say that 'Love is blind.' The original meaning of this must be that the blind god shoots his arrows at random, and thus the mutual attractions

felt by his victims are the results of chance and not of choice. This is obviously untrue. The more usual interpretation is that lovers are blind to one another's faults. Fortunately this is to some extent true; but the inference drawn from it, that they cannot exercise conscious selection of a rational kind is thoroughly false. That 'Love laughs at locksmiths' is also maintained, but in answer it may be said that Love seldom tampers with a well-made lock. Lovers of strong character may refuse to be kept apart by essentially insignificant things; but what they themselves recognise as serious obstacles to their union usually prevent the idea of love from arising in the first instance. Eugenics must teach what may be rightly considered as serious obstacles, but its teaching should not be merely negative. With its spirit the ethics of love and marriage must be imbued. It must place in every heart an image of the ideal lover, to serve both as a guide and a goal; an ideal of all that is best and most desirable in body, mind, and conduct; an ideal which should be founded not on false sentimentality but on a deep and true knowledge of nature. In this way Love and Knowledge will unite 'to grasp this sorry scheme of things' to the end that, patiently and hopefully, with no petulant 'shattering to bits,' they may

Remould it nearer to the heart's desire.

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